

PALESTINE JOURNAL OF BOTANY

Jerusalem Series

EDITED BY

THE STAFF OF THE DEPARTMENT OF BOTANY OF THE HEBREW UNIVERSITY

CONTENTS

	Page
Annual Wood Ring Development in Maquis Trees of Israel. By A. FAHN	1
Ecological Studies in the Vegetation of the Near Eastern Deserts. III. Vegetation Map of the Central and Southern Negev. By D. ZOHARY	27
Nouvelle Contribution à l'Etude de la Mycoflore de Palestine (Sixième Partie). Par TSCHARNA RAYSS	37
Effect of 2,4-D and Coumarin on Respiration of Germinating Wheat and Lettuce Seeds. By RUTH LEVARI	47
Germination Inhibitors and Plant Enzyme Systems. II. Dehydrogenases. By ALEXANDRA POLJAKOFF-MAYBER	60
Isolation of Soil Organisms Antagonistic to Some Phytopathogenic Fungi. By MARGALITH KATZ	67
Summaries in Hebrew	

JERUSALEM
ISRAEL

PALESTINE JOURNAL OF BOTANY

appears in two series

THE JERUSALEM SERIES (J)

Edited by the Staff of the Department of Botany of the Hebrew University, Jerusalem. Each volume of the JERUSALEM SERIES comprises four issues, two issues appearing per annum the size of the volume varying from 250 to 350 pages.

THE REHOVOT SERIES (R)

Edited by H. R. OPPENHEIMER and I. REICHERT, Agricultural Research Station, Rehovot, Israel. Each volume of REHOVOT SERIES comprises two issues, the size of the volume varying from 200 to 250 pages.

Correspondence concerning editorial matters should be addressed for the JERUSALEM SERIES to THE EDITORS, PALESTINE JOURNAL OF BOTANY, P.O.B. 620, JERUSALEM, ISRAEL, for the REHOVOT SERIES to THE EDITORS, PALESTINE JOURNAL OF BOTANY, P.O.B. 15, REHOVOT, ISRAEL.

Subscriptions are payable in advance by crossed cheque or postal order and should be forwarded to the ADMINISTRATION of the PALESTINE JOURNAL OF BOTANY, P.O.B. 620, JERUSALEM, ISRAEL. The subscription price is

£1.10.0 per volume, post free, for JERUSALEM SERIES.

Back volumes are obtainable (as far as still available) at £2.— for JERUSALEM SERIES.

Printed in Israel
Weiss Press, Jerusalem

PALESTINE JOURNAL OF BOTANY

Vol. VI, No. 1

Jerusalem Series

March 1953

ANNUAL WOOD RING DEVELOPMENT IN MAQUIS TREES OF ISRAEL

By A. FAHN

Received December 1951

INTRODUCTION

The question of the development of the annual ring in trees was studied widely at the end of the last century and at the beginning of the present one, in northern and central Europe, and, to a certain extent, in America and in the tropics of the Old World. However, the above researches were done mainly on northern trees and only recently a number of trees from the Mediterranean area have also been studied, i.e. *Pinus halepensis* in Palestine by OPPENHEIMER (1945) and in Italy by MESSERI (1948), *Prunus Amygdalus* and *Rhamnus Alaternus* by PAOLIS (1948 and 1949), *Viburnum Tinus* by MINERVINI (1948), *Arbutus andrachnoides* by VERGANO (1949), *Quercus Ilex* and *Quercus pubescens* by MAUGINI (1949).

The almost complete lack of knowledge regarding the activity of the cambium in the trees of the Israeli maquis and forest which constitute a special phyto-sociological and ecological unit, invited this research. Six species of trees, which make up the principal components of our maquis, were examined. These were *Quercus ithaburensis* (Decne.) Boiss., *Pistacia atlantica* Desf., *Pistacia palaestina* Boiss. and *Crataegus Azarolus* L., all of which are deciduous; and the evergreen *Quercus calliprinos* Webb and *Ceratonia Siliqua* L.

With the study of the anatomical system which shows us the rhythm of activity of the cambium, we hope to advance the knowledge of the ecology of the Israeli maquis.

MATERIALS AND METHODS

Most of the trees examined grew in one habitat—the maquis, at the foot of Mt. Carmel near Yagur. *Pistacia atlantica*, however, grew in an area approximately $1\frac{1}{2}$ km. along the road from Yagur to Tivon, and one of the two specimens of *Crataegus Azarolus* in Jerusalem. Generally, two or more trees were examined from each species. In each tree, samples were taken from the northern and southern side of the trunk at chest height. (In the case of certain very young trees samples were taken at a slightly lower level). Samples were obtained also from the branches of the crown, and in one single case from the base of the trunk. The samples were taken 8–9 times during the year, starting from 18 May 1950 until 26 April 1951. For comparison samples were also taken on 3 September 1951. The various samples were taken two or three cm. apart, laterally, above or below the preceding one. This was done according to the method used by OPPENHEIMER (1945). Chips of the outermost wood were cut out with a chisel; these were 3–10 mm. thick, 8–15 mm. wide and 15–20 mm. long. The chips were placed into test-tubes containing 96% alcohol to which a little glycerine had been added (see GREISS, 1939). After having been kept in this solution 3–4 weeks, microtomic sections 30μ thick were made. Sometimes it was found necessary to boil the samples in water for a short period in order to soften them and to prevent curling of the sections. The sections were mounted in glycerine for observation, though some of them were stained with saffranin and embedded in Canada balsam.

OBSERVATIONS

(i) *Quercus ithaburensis* (Decne.) Boiss.

Two old trees were examined. In tree No. 1 the samples were taken at chest level, where the diameter of the trunk was 16 cm., and from a branch 4 m. above ground (5 cm. in diameter). In tree No. 2 samples were taken 30 cm. above ground (60 cm. in diameter) and at chest level (16 cm. in diameter).

(a) *Structure of the annual ring*

As in other species of *Quercus*, the wood of *Q. ithaburensis* is ring-porous. The vessels appear generally in large radial groups. When seen in cross-section the vessels are slightly elongated radially. Those which develop in the spring have lumina up to 220μ , while those which develop during the summer are narrower and the width of their lumina

at the end of the growing season is 25—50 μ . The wood rays are of two distinct sizes, uniseriate or many cells wide. The wood parenchyma is apotracheal, of the diffuse type (Plate I, 1 and 2).

(b) *Development of the annual ring*

Table 1 shows results of the examinations made during one year.

From this table and from other observations it can be concluded that the development of the annual ring of *Q. ithaburensis* took place as follows :

(1) The cambium started dividing at the end of March (Plate I, 1 and 2). In the cross-sections of the samples taken on 3 April 1951 one new row of wide vessels (160—220 μ) was found at the margin of the wood, as well as fibres which were wider in the radial than in the tangential direction. The fibres between the vessels were, for the most part, not yet lignified, except for the sample of tree No. 1 taken from the northern side of the trunk, where the fibres adjacent to the vessels were lignified. In one single case (the sample taken from the southern side of the trunk of tree No. 1) initiation of cambial activity was already observed on 13 February 1951. This activity was local, as the sample of March was found to be still in full dormancy.

(2) No differences were observed in the times of cambium initiation either in the trunk at ground or chest level, or in the branch. This result is contrary to those obtained for other species of *Quercus* in northern Italy (MAUGINI, 1949), for *Pinus halepensis* in Palestine (OPPENHEIMER, 1945) and for other trees in central Europe (ANTEVS, 1917). The above-mentioned authors state that cambial activity starts in the branches about a month before it begins in the trunk. Our results conform, however, with those of HARTIG (according to ANTEVS, 1917, p. 339) who found in the European *Quercus* simultaneous cambium initiation throughout the tree.

(3) The spring wood was generally formed in April and in the first half of May.

(4) The intermediate xylem was, in most cases, formed in the end of May, June and early July. Only in the samples taken from the northern side of tree No. 1 did intermediate wood continue to be produced on 5 October 1950.

(5) The late wood began to develop usually by the middle of July (In the samples of 16 July 1950 flat fibres began to appear on tree No. 2). According to ANTEVS (1917, p. 346) and MER (1892,

p. 501) as cited by the former (1. c.), the European oak starts producing its narrow wood in the middle of June.

(6) The cambium generally appeared to enter its period of dormancy in August. At the margin of the wood in the samples of 5 October 1950 we already found in most cases some layers of fibres, the radial width of which was by far smaller than their tangential width. In samples taken on 3 September 1951 the cambium was also found to be dormant. In the oaks of central Europe the annual ring is completed by 5 August (according to HARTIG, 1857, p. 230, as cited by ANTEVS, 1917, p. 343).

(7) In a large number of samples taken at the end of summer and in the autumn, false rings were noticeable (Plate I, 2). This has already been observed by MAUGINI (1949) in northern Italy in branches of *Q. Ilex* and in the trunk of *Q. pubescens*. False rings were observed by us in the samples of tree No. 1 taken from the southern side of the trunk on 27 December 1950, and from the northern side on 13 February 1951, as well, as in tree No. 2 on its southern side on 5 October 1950. The false rings could be detected by (1) the formation of fibres of a greater radial than tangential width, which appeared later than the flat fibres formed in July, and (2) by the formation of vessels a little wider than those which were formed at the margins of the true ring. This wood, however, which was being formed in late summer and early autumn, did not encircle the whole trunk, as we could trace it only in some summer and autumn samples.

(c) *Annual ring and the phenology of the tree*

In the above-mentioned trees, which stood without foliage during the winter, the leaf-buds started to open at the beginning of February (tree No. 1 sprouted a little earlier than tree No. 2). The male catkins appeared at the same time and reached the full flowering in the second half of February. In the beginning of March the leaves reached their full development. In April we found new fully-developed twigs. It may be concluded from these observations that although isolated local activity may take place simultaneously with the onset of the unfolding of the leaf-buds, the full division of the cambium cells occurs only after the new leaves are fully developed, i.e. six weeks after the opening of the buds. This phenomenon is different from that observed by MAUGINI (1949) in *Q. Ilex* and *Q. pubescens* in northern Italy and by PRIESTLEY, SCOTT and MALINS (1933) in other oaks in England. These authors state that the cambial activity in the species of *Quercus*

TABLE 1

The development of the annual wood ring in *Quercus ithaburensis* (Decne.) Boiss.

V — The tangential diameter (in μ) of the vessels of the outermost portion of the wood, next to the cambium.

F — The tangential (first column) and radial (second column) diameter in μ of most of the fibres of the outermost portion of the wood, next to the cambium

In the "rate of activity" column :

0 — dormant cambium

I — very weak activity

II — medium activity

III — very strong activity

The activity is determined by the amount of fibres which were not yet fully lignified

Date	Tree No. 1						Tree No. 2					
	Trunk: at height of 130 cm.			Branch: at height of 400 cm.			Trunk: at height of 150 cm.			Trunk: at height of 130 cm.		
	North			South			North			South		
	V	F	rate of activity	V	F	rate of activity	V	F	rate of activity	V	F	rate of activity
18. 5.50	122	15×20	III	98	17×20	III	120	15×20	III	110	16×21	III
19. 6.50	73	15×20	III	110	15×20	III	49	15×22	III	39	15×22	III
16. 7.50	73	17×22	III	—	—	—	49	17×17	I	32	22×10	0
5.10.50	49	15×20	II	—	—	—	56	20×7	0	24	20×10	0
27.12.50	44	20×8	0	34	17×7	0	54	22×10	0	44	23×10	0
13. 2.51	54	17×7	0	147	17×22	III	46	22×8	0	51	22×7	0
8. 3.51	51	18×8	0	73	17×7	0	49	22×8	0	29	22×7	0
3. 4.51	200	12×22	III	220	12×22	III	170	10×22	III	160	12×20	III

with which they worked begins together with or prior to the opening of the leaf-buds. ANTEVS (1917), summing up the results of many investigators who worked on different species and individual trees, states that there is no fixed relation between the sprouting and the onset of division in the cambium. It should be mentioned that the formation of the false annual rings is connected with the awakening of single buds on the twigs during the late summer months (ORSHANSKY—unpublished).

(d) *Width of the annual ring*

The great fluctuations in the width of the ring are caused chiefly by the rate of development of the intermediate wood. The width of the 1950 ring at conclusion of its annual growth in tree No. 1 varied between 1.7—4.2 mm. at the southern side of the trunk and 3.0—4.6 mm. on its northern side, being wider on the northern side of the trunk. On this side we still found formation of intermediate wood at the beginning of October. In the branch of tree No. 1 the maximum width of the completed ring was 1.72 mm. In tree No. 2 we found the width of the ring at the height of 1.50 metres to be 2.0—2.3 mm. on its southern side and 1.6—2.7 mm. on its northern side. The maximum width of the ring was smaller here than in tree No. 1, as the formation of intermediate wood ceased already at the beginning of July. The maximum width of the ring at the base of tree No. 2 was 3.5 mm.

(ii) *Quercus calliprinos* Webb

Two mature trees with single trunks (trees No. 3 and No. 4) were examined. In tree No. 3, samples were taken from the trunk at chest height (16 cm. in diameter), and from a branch at the height of 2.60 m. above ground, (5 cm. in diameter). In tree No. 4 the samples were taken from the trunk at chest height (16 cm. in diameter), and from a branch at the height of 2.80 metres above ground (5.5 cm. in diameter).

(a) *Structure of the annual ring*

The structure of the wood of *Q. calliprinos* differs from that of *Q. ithaburensis*. In the former, the spring vessels are thinner, sparser and their appearance in radial groups is more conspicuous. The fibers of *Q. calliprinos* are also slightly narrower than those of *Q. ithaburensis*. The vessels which develop in the spring have lumina which approach 125 μ in width. The vessels at the margin of the completed ring have lumina 25—45 μ wide, but vessels with lumina 15 μ wide also occur (Plate I, 3).

(b) *Development of the annual ring*

Table 2 presents the results of the examinations which were made during the year.

From this table, and other observations we may come to the following conclusions:

(1) Cambial activity began in full at the end of March (Plate I, 3). In the samples taken on 3 April 1951, vessels with lumina 66—122 μ wide were found, as well as fibres which were wider in the radial than tangential direction. Some of these samples had three layers of new spring vessels with lignified fibres between them; others had only one layer of vessels with the fibres between them not yet entirely lignified. The general impression was that the cambium began to divide a little earlier than in *Q. ithaburensis*. The samples taken on 3 April 1951 from the southern side of the trunk showed the greatest rate of development, but local activity before that date was found on the northern side of the trunk (tree No. 3 on 13 February 1951 and tree No. 4 on 8 March 1951).

(2) Activity of the cambium in the branch of tree No. 4 began slightly earlier than on the northern side of the trunk, but a little later than on the southern side of the trunk. The development of the new ring in the branch of tree No. 3 began slightly later than on both sides of its trunk.

(3) The spring wood was formed during April and the first half of May.

(4) The intermediate wood was formed mainly from the latter part of May till July.

(5) The late wood was apparently formed in August. In the samples of 16 July 1950, the radial width of the fibres still was greater than their tangential width.

(6) The cambium entered dormancy in late August and early September. In any case, this happened here later than in *Q. ithaburensis*, in which fibres greater in tangential than in radial width appeared in the latter half of July. Fibres of intermediate wood were still found in samples of *Q. calliprinos* taken on 16 July 1950.

(7) As in *Q. ithaburensis*, in *Q. calliprinos* too we found false rings formed in late summer and autumn. Such rings or rather parts of rings were found both in the advanced and final stages of formation in the sample taken from the northern side of the trunk of tree No. 4 on 5 October 1950, and in the samples taken from the southern side of the trunk of tree No. 3 on 5 October 1950 and again on 27 De-

cember 1950, as well as in a sample from a branch of tree No. 3 taken on 27 December 1950. In other samples we found false rings (parts of rings) the development of which had already been completed—in tree No. 3, for instance, on the northern side of the trunk on 8 March 1951, and in tree No. 4 on the southern side of the trunk on 27 December 1950.

(c) *Annual ring and phenology of the tree*

In this evergreen tree the new leaves started to develop in early April. The male catkins appeared in the second half of March. Here, the phenological processes are tardier by $1\frac{1}{2}$ months than in *Q. ithaburensis*, but the initiation of cambial activity occurs almost simultaneously in both species (in *Q. calliprinos* even a little earlier).

(d) *Width of the annual ring*

In *Q. calliprinos*, just as in *Q. ithaburensis*, we were able to see that the pronounced fluctuations in the width of the rings are mainly the result of the unequal development of the intermediate xylem. The width of the completed 1950 ring varied in tree No. 3, being 3.2–4.1 mm. on the southern side of the trunk, and 6.4 mm. on the northern side. In this tree we actually found a far larger cambial activity on the northern side of the trunk on 16 July 1950 than we did on its southern side. In the branch of tree No. 3 the maximum width of the ring was 2.6 mm. In the trunk of tree No. 4 the width of the ring was 2.0–2.8 mm. on the southern side, and 2.2–4.3 mm. on the northern side. In the branch of this tree, the maximum width of the ring was 1.7 mm.

(iii) *Crataegus Azarolus* L.

Two small trees were examined, No. 5 in Yagur and No. 6 in Jerusalem. In both, the samples were taken from the trunk at chest height, where the diameter was 10 cm. In the last few months of the research, samples were taken also from a branch of tree No. 5 at the height of 2 m. above ground, where the diameter was 3 cm.

(a) *Structure of the annual ring*

The wood is of the diffuse-porous type. No pronounced difference in the width of the tracheal vessels of the early wood and those of the intermediate wood was found. In the cross-section the vessels were seen to be slightly elongated and to a certain extent polygonal. The width of the lumina of the larger vessels was 30–36 μ , while that of the smaller vessels (found mainly in the late wood) was 12–15 μ . The

TABLE 2
The development of the annual wood ring in *Quercus calliprinos* Webb

Tree No. 3										Tree No. 4					
Trunk: at height of 140 cm.					Branch: at height of 260 cm.					Trunk: at height of 140 cm.			Branch: at height of 280 cm.		
North					South					North			South		
Date	V	F	rate of activity	V	F	rate of activity	V	F	rate of activity	V	F	rate of activity	V	F	rate of activity
18. 5.50	85	12×17	III	98	10×17	III	65	12×15	III	78	10×15	III	—	—	—
19. 6.50	59	12×17	III	78	12×17	III	49	12×15	III	62	15×15	III	—	—	—
16. 7.50	49	15×17	III	58	12×17	II	37	12×15	II	51	15×15	II	—	—	—
5.10.50	54	17×7	0	24	17×7	I	39	15×10	0	27	17×12	I	15	17×7	0
27.12.50	29	19×7	0	36	15×15	I	22	15×13	I	39	20×9	0	26	17×8	0
13. 2.51	105	15×20	III	36	17×12	0	36	17×7	0	27	17×7	0	39	17×8	0
8. 3.51	27	15×10	0	34	17×7	0	61*	15×17*	III*	37	15×10	0	44	17×7	0
3. 4.51	122	10×20	III	105	12×17	III	66	10×17	III	73	15×17	III	85	11×15	III

Explanations as in Table 1.

* The figures are only from a part of the cross-section. The other part was still dormant.

wood rays are homogeneous and many cells wide. The parenchyma is apotracheal, of the diffuse type.

(b) *Development of the annual ring*

Tables 3 and 4 present the results of the examinations made throughout the year in Yagur and Jerusalem.

TABLE 3
The development of the annual wood ring in *Crataegus Azarolus* L.
(Tree No. 5, in Yagur)

Trunk: at height of 130 cm.									Branch: at height of 260 cm. South		
North						South					
Date	V	F	rate of activity	V	F	rate of activity	V	F	rate of activity		
18. 5.50	24	12×17	III	29	12×15	III	—	—	—		
19. 6.50	24	15×17	III	24	12×15	III	—	—	—		
16. 7.50	20	15×12	II	22	15×15	II	—	—	—		
5.10.50	15	14× 5	0	19	13× 7	0	—	—	—		
27.12.50	15	14× 5	0	25	15×13	I	—	—	—		
13. 2.51	17	17× 7	0	25*	13×19*	III*	—	—	—		
8. 3.51	20	17× 7	0	20	17×10	0	22	15×10	0		
3. 4.51	32	12×15	III	34	12×17	III	25	10×15	III		

Explanations as in Table 1.

* These figures are only from a part of the cross-section. The other part was still dormant. Its figures were 17 — 19 × 7 — 0.

TABLE 4
The development of the annual wood ring in *Crataegus Azarolus* L.
(Tree No. 6, in Jerusalem)

Trunk: at height of 130 cm.								
North						South		
Date	V	F	rate of activity	V	F	rate of activity		
13. 6.50	32	10×17	III	25	10×17	III		
16. 7.50	16	15× 8	0	17	15×10	0		
10.10.50	20	15× 7	0	20	15× 9	0		
15. 1.51	20	17× 7	0	17	15× 7	0		
4. 3.51	15	17×10	0	22*	10×17*	III*		
4. 4.51	31	8×15	III	18	17×10	0		
2. 5.51	34	17×17	III	31	10×15	III		

Explanations as in Table 1.

* This sample was still partly dormant. The figures of its dormant part were 15 — 17 X 10 — 0.

From these tables and observations the following conclusions may be drawn:

(1) Cambial activity generally began in late March (Plate II, 1), but local division was found at an earlier date as well. Thus we found, for example, new wood in a part of the sample which was taken from the southern side of the trunk of tree No. 6 on 4 March 1951. In another part of the same sample the cambium was still dormant. Such an early local awakening (only in part of the cross-section) was found also in tree No. 5 on 13 February 1951. An even more astonishing phenomenon was the cambial activity on the southern side of tree No. 5, found in the sample of 27 December 1950. In this sample, about fifteen layers of new fibres and about four layers of new vessels were evident. This activity too, was apparently only local, for in the sample of 8 March 1951 we found the cambium to be completely dormant even on the same side of the trunk, and the wood showed no signs of an additional ring. Full activity of the cambium was found in samples taken from both sides of tree No. 5 on 3 April 1951. These particular samples by this time showed four or more layers of new vessels and the fibres between them were already lignified. On the northern side of the trunk of tree No. 6 we found on 4 April 1951 about six layers of new vessels with completely lignified fibres between them. On the other hand, we did not at that date find any cambial activity on the southern side of the trunk, but on 2 May 1951 the wood on this side was already twice as wide (1.1 mm.) as the new wood on the northern side of the trunk (0.6 mm.).

(2) In the branch of tree No. 5, we found, on 3 April 1951, one row of vessels that had just appeared in the cambium. Here there had been a certain delay in the cambial awakening as compared to that of the trunk.

(3) The early wood was formed in April and May.

(4) The intermediate wood was formed in June and early July.

(5) The late wood was formed in July. In the samples of 16 July 1950, we found in tree No. 5 a number of layers of flat fibres at the margin of the wood, and in tree No. 6 on the same date no activity was evident.

(6) The cambium appeared to enter dormancy in late July and during August.

(c) *Annual ring and phenology of the tree*

The leaf buds began to open in tree No. 5 (in Yagur) in the first half of February and the flower buds started opening by about the middle of March. In early March the tree was completely covered with

new mature leaves, and in early April we already found new branches. The phenological processes of tree No. 6, which grew in Jerusalem, took place about three weeks later than in tree No. 5, growing in Yagur. Here, as in *Quercus ithaburensis*, the general onset of cambial division occurred 4–6 weeks later than the opening of the leaf-buds.

(d) *Width of the annual ring*

In tree No. 5 the width of the 1950 annual ring was 1.3–2.9 mm. on the southern side of the trunk, and 2.0–3.1 mm. on its northern side. In tree No. 6, which grew in Jerusalem, we were able to determine the width of the 1950 annual ring as 0.4–1.3 mm. on the southern side of the trunk, and 0.4–1.5 mm. on its northern side. Thus, the ring of the Yagur tree was much wider than that of the Jerusalem tree, but in both of them the northern side showed a slightly greater development than the southern side.

(iv) *Pistacia atlantica* Desf.

The tree examined (No. 7) grew at a distance of about $1\frac{1}{2}$ km. from Yagur, on the valley highway. At the height of 1 m. the trunk split in two; the samples were taken from the southern side at chest height where the diameter of the trunk was 20 cm. The branch used for samples was 2 m. above the ground and 3 cm. thick.

(a) *Structure of the annual ring*

The wood in this tree belongs to the ring-porous type. The early wood is very narrow and consists of the usual arrangement of one layer of fairly large vessels (whose lumina are sometimes as wide as $105\ \mu$) and one or two layers of smaller vessels, arranged in radial groups. The main portion of the ring is made up of intermediate wood which contains also small radial groups of vessels of even smaller diameter ($10\text{--}25\ \mu$). The late wood consists of a very small number of vessels whose lumen is on the average $10\text{--}15\ \mu$ wide. The wood rays are many cells wide. The wood parenchyma is paratracheal and scanty (Plates I, 4 and II, 6).

(b) *Development of the annual ring*

Table 5 describes the results of the examinations carried out in the course of one year.

TABLE 5

The development of the annual wood ring in *Pistacia atlantica* Desf.

Trunk: at height of 140 cm.										Branch : at height of 200 cm. South		
North						South						
Date	V	F	rate of activity	V	F	rate of activity	V	F	rate of activity	V	F	rate of activity
19. 6.50	29	10×14	III	15	10×15	III	—	—	—	—	—	—
16. 7.50	26	12×20	III	12	10×15	III	—	—	—	—	—	—
5.10.50	17	10×20	III	12	22×10	0	—	—	—	—	—	—
27.12.50	19	20×10	0	15	17× 7	0	—	—	—	—	—	—
13. 2.51	22	20×10	0	17	17× 7	0	10	12× 7	0	—	—	—
8. 3.51	12	17× 9	0	12	19× 7	0	17	15× 7	0	—	—	—
3. 4.51	73	10×15	III	90	12×17	III	66	10×15	III	—	—	—
31. 5.51	44	10×20	III	—	—	—	—	—	—	—	—	—

Explanations as in Table 1.

From results given in Table 5 as well as from other tests the following conclusions may be drawn:

(1) Initiation of cambial activity started at the end of March (Plates I, 4 and II, 6). In the sample taken on 3 April 1951 from the northern side of the trunk we found one layer of large new vessels and groups of one to three smaller vessels. The fibres which were located between these vessels were almost completely lignified. In the southern sample of the same date the new wood was found to be somewhat less developed than in the northern sample.

(2) Initiation of cambial activity in the branch was somewhat later than in the trunk. On 3 April 1951 we found in the branch one row of new spring vessels but the fibres, except a few near the vessels, had not yet begun to be lignified.

(3) The early xylem was formed during the month of April.

(4) The intermediate xylem developed between May and August and even in the early part of October, as can be seen from the sample of 5 October 1950 from the northern side of the trunk.

(5) The late xylem was formed according to our data in September—October. On 5 October 1950 the cambium on the southern side was found to be already dormant; on the northern side, however, it was still very active, giving rise to fibres whose radial width was greater than their tangential.

(6) The cambium entered dormancy during the period of end of September—end of October.

(c) *Annual ring and phenology of the tree*

The tree began to sprout in the beginning of March, particularly on its northern side, one month later than *Crataegus Azarolus* and *Quercus ithaburensis*; but division of the cambium cells began at about the same time in all three species. It should be pointed out, however, that, unlike in the previously mentioned species of trees, in *Pistacia atlantica* we did not find any localised cambial activity before the end of March.

It is worthwhile to note that in tree No. 7 both sprouting and cambium activity started earlier on the northern than on the southern side.

(d) *Width of the annual ring*

Here too the fact stands out that the ring on the northern side of the trunk was broader than on the southern. The width in 1950 to the north was at least 5.8 mm. (in other samples the sections were over 5.5 mm. even though they did not include the whole width of the ring). On the southern side the width was 2.6—4.3 mm.

The width of the ring in the branch examined was 0.2—0.3 mm.

(v) *Pistacia palaestina* Boiss.

Four specimens were examined, all in Yagur. Two of them (Nos. 8 and 9) were shrubs and two (Nos. 10 and 11) trees. No. 8 was a somewhat stunted shrub; its samples were taken 1 m. from the base of the trunk at a diameter of 8 cm. and from a branch 2 m. high at a thickness of 3 cm. No. 9 was a sturdy shrub; samples from it came from 1.3 m. above the base of the trunk where its diameter was 7 cm. and from a branch at 2 m. height and 3 cm. thickness. No. 10 was a bushy tree, very strong and well developed; samples were taken from its trunk at a height of 1.4 m. where its diameter was 12 cm. and from a branch at 3.7 m. height and 3.5 cm. thickness. No. 11 was a well developed tree, but during the sprouting season it did not appear to be in good condition. Samples from No. 11 were taken 1.6 m. above the base where the diameter of the trunk was 13 cm. and from a branch at a height of 2.5 m. and 3 cm. thickness.

(a) *Structure of the annual ring*

The wood of *Pistacia palaestina* is ring-porous like that of *P. atlantica*. The medullary rays are many cells wide. The wood parenchyma is paratracheal and scanty. The large spring vessels stand out much more clearly than in *P. atlantica* since they are larger in

diameter, while the diameter of the lumina of the two other kinds of vessels is more or less the same.

Within the species there are great differences in structure of xylem between the younger and the older specimens. In the younger trees the early vessels are larger and more numerous. Thus we found that in trees Nos. 8 and 9 the width of the lumen of the large vessels reaches 150 μ , in No. 10 — 120 μ , and in No. 11 the maximum was only 75 μ . (Plate II, 2 and 3).

The wood in the branches of the older trees is much like the wood of the main trunk of the younger specimens.

(b) *Development of the annual ring*

The following table (Table 6) gives the results for three of the four trees examined.

From this table and from results of other examinations we can determine the rate of development of the annual ring in *Pistacia palaestina*:

(1) Cambial activity began at the end of March—beginning of April (Plate II, 2 and 3). In tree No. 9 we found one row of new vessels in all the samples collected on 3 April 1951. In the sample from the northern side of the trunk the fibres around and between the new vessels were already all lignified, while on the southern side only the fibres located around the vessels had begun to lignify.

In tree No. 11 we found on 3 April 1951 only the very beginning of a new ring. On both the southern and the northern sides of the trunk we observed one row of new vessels and only the fibres surrounding the vessels were lignified.

The trunk of No. 10 was still in its dormancy on 3 April 1951 on both sides, but in the sample from 26 April 1951 we already found the development of the new ring to be advanced. On this latter date, the layer of large vessels was already surrounded by 12—14 layers of fibres. The northern sample showed greater development than the sample from the southern side of the trunk.

(2) There were some differences in cambial growth in the trunks and branches examined. In tree No. 9 the activity of the cambium in trunk and branch began at about the same time (in the branch somewhat later). In tree No. 10 we found already some development in the branch on 3 April 1951 (there were new vessels surrounded by woody fibres), while on this date the trunk was still dormant. New wood in the trunk was found only in the sample of 26 April, about two weeks after the end of dormancy in the branch. The branch of tree No. 11

which was still dormant on 3 April 1951, showed localised cambial growth on 8 April, and full activity on 26 April. On the last date we observed two layers of new vessels and about 20 layers of new lignified fibres. In the trunk of this tree we found general activity on 3 April, but on 26 of that month the new wood consisting of only one layer of vessels and the surrounding fibres lignified. Thus in tree No. 11 overall activity of the cambium began later in the branch than in the trunk but the rate of growth in the early part of the season was much greater in the branch.

(3) The early wood was formed during April—May.

(4) The intermediate wood was formed in most cases during June—July (in No. 9 during the month of June only).

(5) The late wood was formed during end of July—August. On 16 July 1950 we found flat fibres on both sides of the trunk of tree No. 9. In tree No. 11 there were only a few layers of flat fibres on the northern side of the trunk, while on the same date, on the southern side the cambium was still giving rise to intermediate xylem. In tree No. 10 the July samples from both sides of the trunk showed only fibres whose tangential width was smaller than their radial width.

(6) The cambium entered its dormancy during the period of late August to beginning of September. In tree No. 9, however, dormancy had already started in the middle of July. It is likely that this was connected with the age of the plant, since No. 9 was a comparatively young shrub.

(c) *Annual ring and the phenology of the tree*

The buds opened generally in early March. In tree No. 9 only a few swollen buds were found at the beginning of March; most buds were still in complete dormancy. In tree No. 10 the buds were then already open at that time and the leaves considerably expanded (1.5 cm. long). On the same date in tree No. 11 the buds of the lower branches began to open.

It can be seen from the above that the opening of the buds began generally 3—5 weeks before the initiation of cambial activity.

(d) *Width of the annual ring*

The annual ring in young shrubs is narrower than in more mature shrubs or trees. Thus we found the thickness of the ring in shrub No. 9 in 1950 to be 0.8—1.1 mm., in bushy tree No. 10 — 0.8—1.9 mm. and in tree No. 11 — 0.6—3.0 mm.

There was an appreciable difference in the thickness of the rings

TABLE 6
The development of the annual wood ring in *Pistacia palaestina* Boiss.

Date	Tree No. 9						Tree No. 10						Tree No. 11					
	Trunk: at height of 130 cm.			Branch: at height of 200 cm.			Trunk: at height of 140 cm.			Branch: at height of 370 cm.			Trunk: at height of 160 cm.			Branch: at height of 250 cm.		
	North	South	South	V	F	rate of activity	North	South	South	V	F	rate of activity	North	South	South	V	F	rate of activity
18. 5.50	120	10x12	III	61	10x15	III	—	—	—	49	10x16	III	—	—	—	—	—	—
19. 6.50	49	12x15	II	20	10x15	III	—	—	—	27	8x17	III	—	—	—	—	—	—
16. 7.50	29	15x12	I	49	15x 8	I	29	7x15	III	27	13x15	II	—	—	—	—	—	—
5.10.50	39	15x12	0	30	15x10	0	15	13x10	0	26	12x 7	0	—	—	—	—	—	—
27.12.50	42	17x10	0	20	17x 8	0	27	12x10	0	17	10x12	II	—	—	—	—	—	—
13. 2.51	—	—	—	45	15x10	0	15	15x10	0	29	12x 7	0	—	—	—	—	—	—
8. 3.51	17	15x 7	0	22	17x10	0	17	12x 7	0	12	12x10	0	—	—	—	—	—	—
3. 4.51	98	10x17	III	80	7x19	III	42	12x10	0	12	12x 8	0	12	12x10	0	27*	10x17*	III*
26. 4.51	—	—	—	—	—	—	39	7x15	III	49	10x15	III	90	10x12	III	61	12x17	II
													26	10x12	II	55	10x17	III

Explanations as in Table 1.

* This sample was still partly dormant. The figures of its dormant part were 20 — 12 x 7 — 0.

** The tangential diameter of the vessels behind the margin layer was 103 μ .

on the northern and southern sides of the trunks. On the northern side of No. 11 the ring was 2.3—3.0 mm. wide, while on its southern side it was only 0.6—1.2 mm. We did not find differences like these in the shrubs. The ring of No. 10 (a bushy tree) was of almost equal thickness on both sides of the trunk. In the young shrub (No. 9) it was even somewhat wider on the southern side.

The annual ring of the branches was, of course, a great deal narrower than of the trunks and in general, there was a direct relationship between thickness of ring in trunk and branch.

(vi) *Ceratonia Siliqua* L.

Three trees, all in Yagur, were examined, No. 12 an old male tree of 10 m. height, stood among a group of trees of similar age and appearance. Samples from it were taken from the trunk 1.3 m. above ground. At this height its diameter was 28 cm. We also collected samples from two of its branches, one at a height of 5.5 m. at a thickness of 8 cm. and the second at 6.5 m. where the branches were 3.5 cm. thick.

No. 13 was a young, somewhat stunted tree, which stood in the shade of some other trees. Samples from it came from the trunk at 1 m. height where its diameter was 8 cm.

No. 14 was a strong dense shrub but the trunk was in poor condition during the year of the examinations (perhaps due to the removal of samples). In April 1951 we found most of the leaves of the crown to be yellow. We collected samples from its thickest stem 1 m. above the base where its diameter was 10 cm., and from a branch at 2.5 m. height where it was 3.5 cm. thick.

(a) *Structure of the annual ring*

The wood of *Ceratonia Siliqua* is of the diffuse-porous type. There is no difference between spring vessels and those formed in the summer or fall. The vessels are generally arranged in radial groups of 2-5, only a few are solitary. The lumen of the large vessels was found to reach a maximum of 125—130 μ , but in some of the vessels (the solitary ones or those at the edges of the radial groups) it was as narrow as 40 μ .

The fibres too were of one type in the whole ring. Those at the edges of the ring were not flattened as is usually the case in the late wood of other trees.

The medullary rays were many cells wide. The wood parenchyma was found to be of two kinds: (1) the paratracheal, whose distribution is determined primarily by the vessels and, (2) the apotracheal type,

in which the distribution is fundamentally independent from the vessels. The paratracheal parenchyma in our example was aliform—confluent, i.e. a sheath of parenchyma projected from the sides and in many places the parenchyma around some of the vessels was linked, thus forming bands.

In the trees of *C. Siliqua* studied the apotracheal parenchyma of one or more layers was terminal, i.e. located between the end of one growth ring and the beginning of the next (Plates I, 5 and II, 4 and 5).

Thus in No. 12 we found primarily multi-layered terminal parenchyma, while that in Nos. 13 and 14 was one-layered. This terminal parenchyma is the only means of determining the boundaries of the annual ring in the carob. But even this is not always a certain guide in small microscopic sections because of the simultaneous presence of aliform-confluent paratracheal parenchyma which sometimes extends from one end of the section to the other.

(b) Development of the annual ring

Table 7 gives the stages in the development of the cambium in the course of one year.

TABLE 7
Stages in cambial activity in *Ceratonia Siliqua* L.

		Tree No. 12				Tree No. 13		Tree No. 14		
		Trunk : at height of 130 cm.		Branches : at height of		Trunk : at height of 100 cm.		Trunk : at height of 100 cm.	Branch : at height of 350 cm.	
Date	North	South	550 cm.	650 cm.	North	South	North	South		
18. 5.50	III	III	III	—	III	III	0	III	—	
19. 6.50	III	III	III	—	III	III	II	III	—	
16. 7.50	III	III	—	—	III	III	III	II	—	
5.10.50	—	—	I	—	II	III	III	I	—	
27.12.50	IIp	IIp	I	—	II	IIp	IIp	IIp	—	
13. 2.51	Ip	Ip	Ip	Ip	Ip	Ip	0	Ip	0	
8. 3.51	Ip	0	Ip	0	0	0	Ip	0	0	
3. 4.51	—	0	0	0	0	III	0	0	0	
26. 4.51	III	III	III	0	III	III	III	III	III	

Explanations of the symbols of the degree of activity as in Table 1.
p = appearance of the terminal wood parenchyma.

From this table and from results of other examinations we may draw the following conclusions:

(1) Cambial growth in the carob tree began in general in the middle of April (on 3 April 1951 we found almost all the samples to

be dormant, while on 26 April new xylem already appeared (Plates I, 5 and II, 4 and 5).

(2) Activity began simultaneously in trunks and branches. In one branch of tree No. 12 (height 6.5 m., thickness 3.5 cm.) even somewhat later.

(3) There was no way of distinguishing between spring, intermediate, or late wood but it was possible to determine the varying rate of development of the cambium during the different seasons. The period of greatest activity—indicated by the presence of many layers of new fibres still in the process of lignification—took place until August. After that, the rate diminished. Until the end of December there was continued formation of vessels, fibres and paratracheal parenchyma. Very weak activity of the cambium continued until the middle of February and even into March. During this period primarily the apotracheal terminal parenchyma was formed, completing the annual ring (Plate II, 5).

(4) The dormancy of the cambium was very short. It lasted from the end of February—beginning of March till the beginning of April— $1\frac{1}{2}$ to 2 months.

Cambial growth during all or most of the year was also found in Italy in *Viburnum Tinus* and in *Rhamnus Alaternus* (MINERVINI, 1948; PAOLIS, 1949).

(c) *Annual ring and the phenology of the tree*

In carob, cambial activity began simultaneously with the opening of the leaf buds. On 3 April 1951 the leaf buds were still dormant and our samples also showed no cambial divisions. On 26 April we already found new leaves at the tips of the branches which were 10 cm. long or more.

The continued activity of the cambium until February can also be attributed to the fact that sprouting continued for several months and that the tree blossomed in December.

DISCUSSION AND CONCLUSIONS

An analysis of the data presented above on the development of the annual ring in the six tree species, *Quercus ithaburensis*, *Q. calliprinos*, *Pistacia atlantica*, *P. palaestina*, *Crataegus Azarolus* and *Ceratonia Siliqua* which are the main components of the Israeli maquis, leads us to the following conclusions (Fig. 1) :

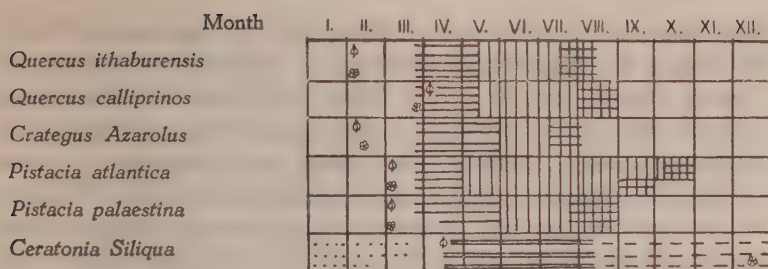
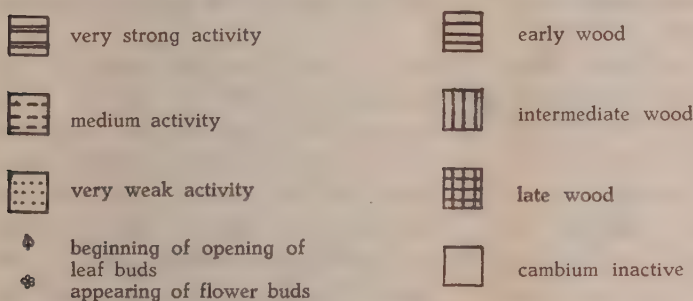


Fig. 1

The development of the annual wood ring in the six tree species investigated



Cambial activity begins in *Quercus ithaburensis*, *Q. calliprinos*, *Crataegus Azarolus*, *Pistacia palaestina* and *P. atlantica* at the end of March, whereas in *Ceratonia Siliqua* only in the middle of April.

Comparing the data obtained for the *Quercus* species growing in Israel with those cited by MAUGINI (1949) for *Q. Ilex* and *Q. pubescens* in Italy, it appears that the onset of cambial activity in Israel precedes that in Italy (end of April) by a whole month. The same relation exists between the beginning of cambial activity in *Pinus halepensis* in Israel, which occurs in February (OPPENHEIMER, 1945), and that growing in Italy, which takes place in March (MESSERI, 1948). (In other Italian tree species, however, as in the almond tree and in *Rhamnus Alaternus*, division of the cambium was found already in March, but it is possible that in Israel, too, these trees awake earlier). Still greater differences exist between the beginning of cambial activity in trees of Israel and of central and northern Europe. According to ANTEVS (1917, pp. 336—340) in central and northern Europe the cambium begins to divide generally in May, i.e. one to two months later than in Israel.

(2) The cambium remains active in *Crataegus Azarolus* and *Pis-*

tacia palaestina from the end of March (or the beginning of April) till August (or beginning of September), i.e. during five months; in *Pistacia atlantica* from the end of March till the end of September (or even till the end of October), i.e. during six to seven months. In *Q. ithaburensis* and *Q. calliprinos* the annual ring is completed in about five months, generally from the end of March till the middle of August. In these oaks the cambium shows a period of secondary activity during the late summer months and in the fall. This period lasts for about one or two months and during these false and incomplete rings are formed. In *Ceratonia Siliqua* the period of cambial activity is protracted over ten to eleven months—from the middle of April till the middle of February or March.

If we consider *Pinus halepensis*, in which the active period of cambium lasts some nine months (OPPENHEIMER, 1945) in addition to the trees here investigated, and compare these date with the duration of cambial activity in various trees in central and northern Europe and in Italy as well, the following relation will be observed: The period of cambial activity in the local trees is $1\frac{1}{2}$ —2 times as long as in trees of central and northern Europe. (According to ANTEVS, 1917, p. 344, there is a period of secondary growth in thickness which lasts three and a half months in *Larix* and *Quercus*, four and a half in *Pinus* and three in *Acer*). The duration of cambial activity in our trees is more or less equal to that found in Italy. The cambium in *Pinus halepensis* divides actively during nine months (MESSERI, 1948); in *Prunus Amygdalus* seven months (PAOLIS, 1948); in *Viburnum Tinus* almost all the year round (MINERVINI, 1948); in *Quercus Ilex* and *Q. pubescens* about four and a half months (MAUGINI, 1949); in *Rhamnus Alaternus* only four months of real activity could be ascertained, whereas during the remaining months division of cambium cells was slight and irregular (PAOLIS, 1949).

(3) Evidence that temperature is not a limiting factor in our country is found in the fact that in some cases cambial activity was discovered also during the winter. Neither is the lack of precipitation during the summer months a decisive factor in determining the extent of the development of the ring, since the deep-rooting trees get the required minimum of moisture even during the dry season. We find confirmation of this in the fact that in *Ceratonia Siliqua* the cambium divided actively during the whole summer and autumn and entered its rest period only in late February and the beginning of March, i.e. the rainy season. All those facts corroborate the accepted view that

climate cannot fundamentally change the process of the development of the annual ring which is a rhythmical process characteristic of each species (BUENNING, 1948, p. 61).

However, even if climate is not a limiting factor in this country, it does have some influence on the time and duration of cambial activity—which starts, as stated above, earlier than in Italy and Europe and lasts longer than in Europe.

(4) The relation between the opening of the leaf buds and the beginning of cambial growth was found to be as follows: In deciduous trees (*Quercus ithaburensis*, *Crataegus Azarolus*, *Pistacia atlantica* and *Pistacia palaestina*) sprouting begins before the initiation of cambial activity; in evergreen trees (*Quercus calliprinos* and *Ceratonia Siliqua*) the leaf buds open simultaneously with cambium initiation (in *Q. calliprinos* the beginning of cambial activity was observed a little later than the opening of the leaf buds but at the same time as that of the flower buds). The cause of the difference in behaviour between the deciduous and the evergreen trees can be explained in two ways, but in our opinion only a combination of them can give an acceptable answer. GOUWENTAK and MASS in 1940 and GOUWENTAK in 1941 tried to induce activity of the cambium in shoots of some trees in the autumn, winter and early spring months by applying heteroauxin. They stated that: "There are two factors involved in the resumption of cambial growth: a growth-promoting substance and a factor breaking the rest period". If we accept this opinion we may be able to explain the difference found in the two types of trees studied. In deciduous trees the factor breaking the rest period appears already with the opening of the leaf buds; the growth-promoting substances, however, begin to flow abundantly in the direction of the cambial region only after new leaves have already developed. In evergreen trees the old leaves contain reserves of growth-promoting substances and the activity in the cambium and in the leaf buds starts immediately after the appearance of the factor breaking the rest period.

The second explanation is connected with nutritive substances. In evergreen trees at the time when the factor breaking the rest period appears, the tree has considerable quantities of nutritive substances formed by photosynthesis in old leaves. These quantities suffice for the development of the new buds as well as for the beginning of cambial growth. In deciduous trees on the other hand, all the reserves are used up at first for the opening of the leaf buds, and only with the appear-

ance of the young leaves are fresh nutrient substances produced and can be used by the cambium cells.

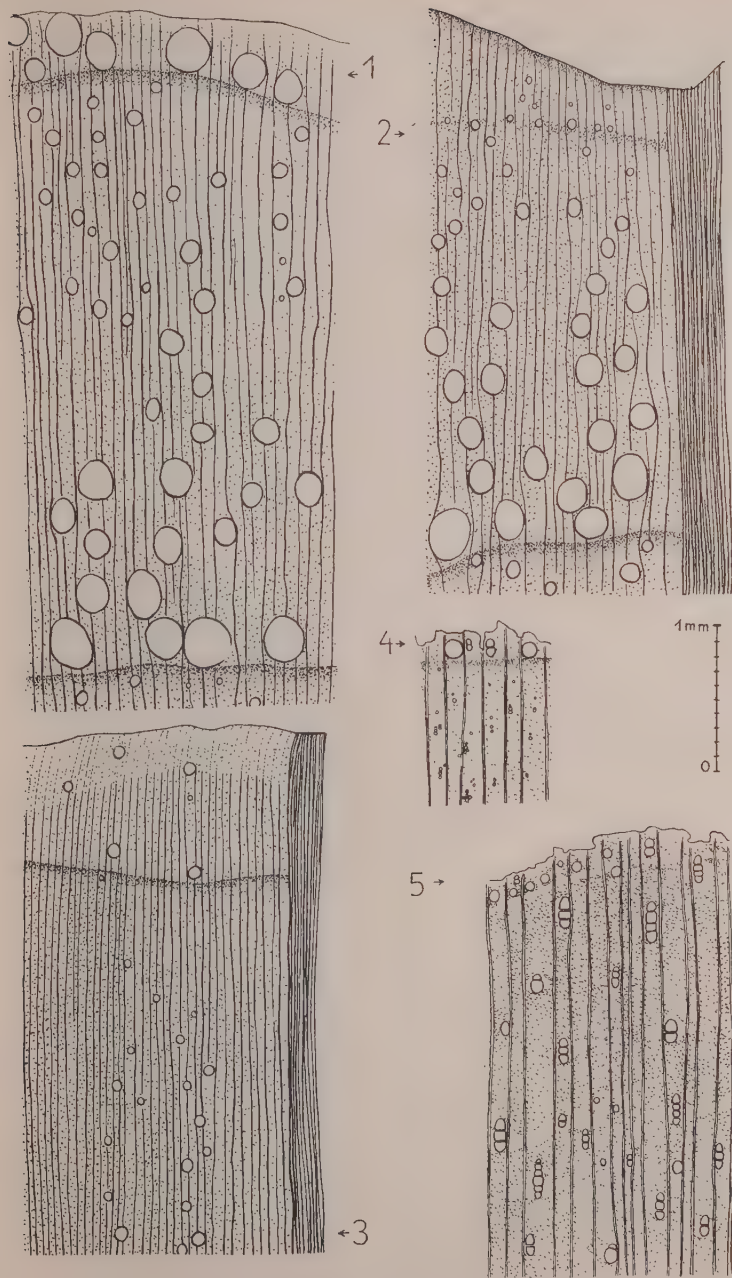
According to several papers on cambial growth in deciduous trees of central Europe and Italy, the cambium and the leaf buds, in most cases, begin activity simultaneously. This is not in contradiction with our above observations.

In Europe, owing to summer rains, the trees form ample food reserves which at the breaking of the rest period suffice both for bud opening and for cambial division at the same time. In climates with a long dry season, as in this country, the trees cannot store great reserves of food and the newly produced assimilatory products suffice only for one process, namely for that of forming new leaves. This is further corroborated by the fact that sporadic cambial activity was found at the time of breaking of the rest period. This is considered evidence for the supposition that the factor breaking the rest period appeared also in the cambium, but due to the lack of either growth promoting substances, or food, or both, the cambium could not divide in the whole of the stems or the branches.

(5) On the whole it was found that the cambium starts dividing simultaneously in stems and branches. Only in one specimen of *Pistacia palaestina* did the cambium of the branch begin its activity two weeks earlier than in the stem, whereas in another specimen cambial activity in the branch was delayed by a fortnight. In other species and in various specimens slight divergences (of a few days) were observed between the start of cambial growth in branches and stems, but they were not constant and therefore need not be taken into account.

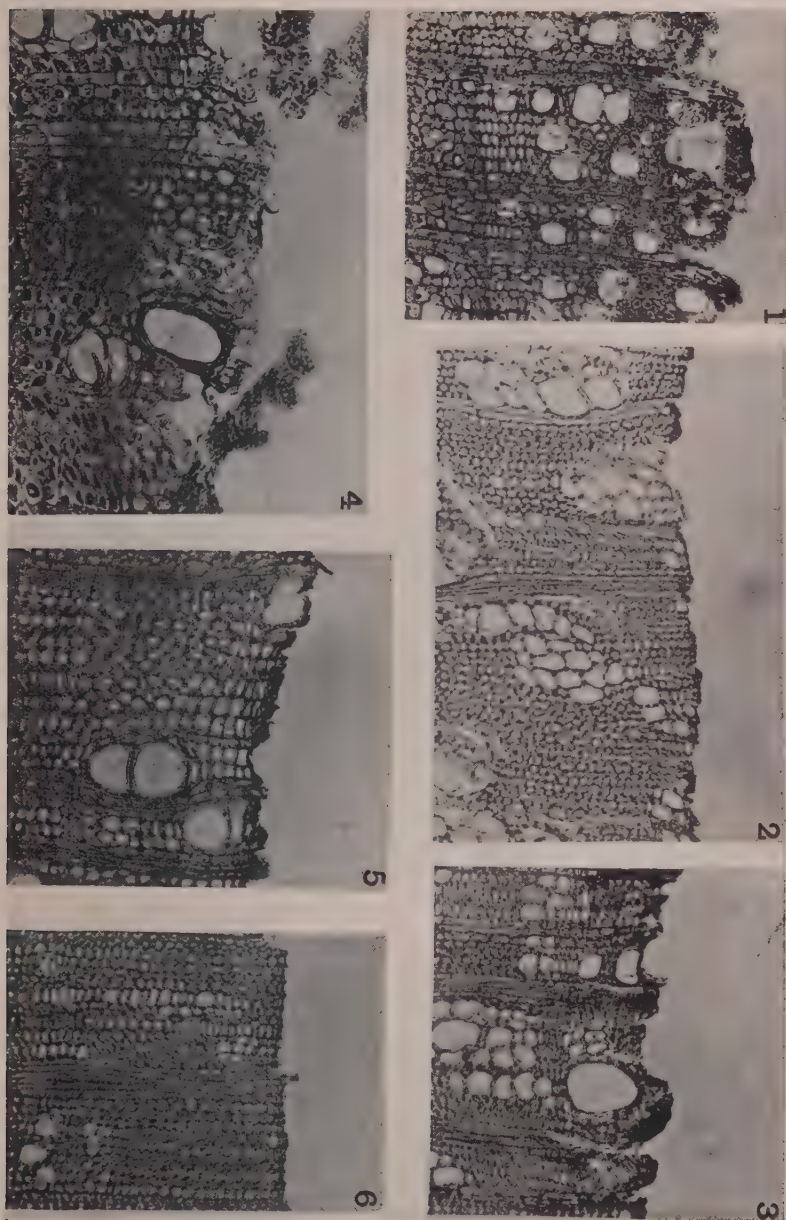
(6) The differences between the beginning of cambial activity on southern and northern sides of the stem are slight. In the trees examined they were as follows: In *Pistacia palaestina*, *Pistacia atlantica*, *Crataegus Azarolus* and *Quercus ithaburensis* (all of them deciduous) cambial activity was more advanced on the northern side of the stem, whereas in *Quercus calliprinos* and *Ceratonia Siliqua* (evergreens) on its southern side.

(7) Width of the annual ring increases downwards (from the upper to the lower part of the stem) as was also stated by ANTEVS (1917, p. 297) for trees with relatively large crowns and for solitary trees densely covered with branches down to the base. It was possible to observe, in all the cases examined, that the annual ring was wider on the northern than on the southern side of the stem, which is more exposed to the drying sun rays.



Cross-sections of the outermost wood of the trunk at chest height.

- 1 and 2. *Quercus ithaburensis*, samples taken on 3.4.51, northern side (1) and on 27.12.50, southern side (2); in the latter a false ring can be seen.
 3. *Quercus calliprinos*, 3.4.51, southern side. 4. *Pistacia atlantica*, 3.4.51, northern side. 5. *Ceratonia Siliqua*, 26.4.51, southern side.



Cross-sections of the outermost wood of the northern side of the trunk at chest height.

1. *Crataegus Azarolus* on 3.4.51, 2-3, *Pistacia palaestina* on 27.12.50 (2) and 3.4.51 (3) respectively. 4-5, *Ceratonia Siliqua* on 26.4.51 (4) and 27.12.51 (5) respectively. 6, *Pistacia atlantica* on 8.3.51.

FAHN — ANNUAL WOOD RING DEVELOPMENT

SUMMARY

The rhythm of the development of the annual ring in the trunk and branches of the following trees was examined: *Quercus ithaburensis* (Decne.) Boiss., *Quercus calliprinos* Webb, *Pistacia palaestina* Boiss., *Pistacia atlantica* Desf., *Crataegus Azarolus* L. and *Ceratonia Siliqua* L.

The examinations have shown:

(1) Full cambial activity in the first five of the trees mentioned began at the end of March, in *Ceratonia Siliqua* in the middle of April.

(2) The annual wood ring was completed in *Quercus ithaburensis* in the middle of August, in *Q. calliprinos* at the end of August, in *Crataegus Azarolus* at the end of July and the beginning of August, in *Pistacia atlantica* as from the end of September till the end of October, in *P. palaestina* at the end of August.

(3) In *Ceratonia Siliqua* the cambium remained active till February—March.

(4) Cambial activity began in the deciduous trees 4 to 6 weeks later than the opening of leaf buds, and in the evergreen trees both processes began simultaneously.

ACKNOWLEDGEMENTS

Thanks are due to Mr. I. Amdursky for technical help in taking the samples.

Department of Botany
Hebrew University
Jerusalem

REFERENCES

- ANTEVS, E. (1917). Die Jahresringe der Holzgewächse und die Bedeutung derselben als klimatischer Indikator. *Progr. Rei bot.* 5: 285-386.
- BROWN, H. P., PAUSCHIN, A. J. and FORSAITH, C. C. (1949). *Textbook of wood technology*. New York, McGraw-Hill.
- BUENNING, E. (1948). *Entwicklungs- und Bewegungsphysiologie der Pflanze*. Berlin, Springer.
- GOUWENTAK, C. A. (1941). Cambial activity as dependent on the presence of growth hormone and the non-resting conditions of stems. *Proc. Acad. Sci. Amst.* 44: 654-663 (cited after abstract in *Bot. Zbl.* 35).
- and MASS, A. L. (1940). Kambiumtätigkeit und Wuchsstoff. II. *Meded. Landb. Hooges. Wageningen* 44: 3-16.

- GREISS, E. A. M. (1939). Effect of water supply on the structure of the xylem elements in certain trees in Egypt. *Bull. Inst. égypt.* 20: 193-255.
- JACCARD, P., v. (1936). Mikroskopische Holzstruktur und Holzbestimmung. *Schweiz. Z. Forstw.* 2 & 3: 1-32.
- JEFFREY, E. Ch. (1917). *The anatomy of woody plants*. Chicago, Univ. Chicago Press.
- MAUGINI, E. (1949). L'evoluzione della cerchia legnosa in *Quercus pubescens* W. e in *Quercus Ilex* L. nel clima di Firenze. *Nuovo G. bot. ital.* N. S. 56: 593-611.
- MESSERI, A. (1948). L'evoluzione della cerchia legnosa in *Pinus halepensis* Mill. in Bari dal luglio 1946 al luglio 1947. *Nuovo G. bot. ital.* N. S. 55: 111-132.
- METCALFE, C. R. and CHALK, L. (1950). *Anatomy of dicotyledons*. Oxford, Clarendon Press.
- MINERVINI, I. (1948). Ciclo di accrescimento e differenziazione delle gemme in piante perenni nel territorio di Bari. IV. L'evoluzione della cerchia legnosa in *Viburnum Tinus* L. dal dicembre 1946 al novembre 1947 a Bari. *Nuovo G. bot. ital.* N. S. 55: 433-445.
- OPPENHEIMER, H.R. (1945). Cambial wood production in stems of *Pinus halepensis*. *Palest. J. Bot. Rehovot* 5: 22-51.
- PAOLIS, D., de (1948). Ciclo di accrescimento e differenziazione delle gemme in piante perenni nel territorio di Bari. III. L'evoluzione della cerchia legnosa in *Prunus Amygdalus* Stokes dal dicembre 1946 al dicembre 1947. *Nuovo G. bot. ital.* N. S. 55: 214-234.
- (1949). Ciclo di accrescimento e differenziazione delle gemme in piante perenni nel territorio di Bari. V. L'evoluzione della cerchia legnosa in *Rhamnus Alaternus* L. dal dicembre 1946 al marzo 1949. *Nuovo G. bot. ital.* N. S. 56: 328-338.
- (1950). Considerazioni sulla variabilità della cerchia legnosa del Mandorlo. La luce e un fattore importante? *Nuovo G. bot. ital.* N. S. 57: 210-222.
- PRIESTLEY, J. H. (1930). Studies in the physiology of cambial activity. I, II, III. *New Phytol.* 29: 56-73, 96-140, 316-354.
- SCOTT, L. I. and MALINS, M. E. (1933). A new method of studying cambial activity. *Proc. Leeds phil. lit. Soc.* 2: 365-374.
- VERGANO, O. (1949). L'evoluzione della cerchia legnosa in *Arbutus andrachnoides* Link. in Firenze, dal luglio 1946 al giugno 1947. *Nuovo G. bot. ital.* N. S. 56: 639-645.

ECOLOGICAL STUDIES IN THE VEGETATION OF THE NEAR EASTERN DESERTS

III. VEGETATION MAP OF THE CENTRAL AND SOUTHERN NEGEV

By D. ZOHARY

Received July 1952

INTRODUCTION

The aim of this paper is to outline the vegetation of the central and southern part of the Negev (Southern Israel). The greater part of this region is dominated by extreme desert conditions and was till recently almost "terra incognita" to students of Natural History.

As the Negev district is at present a subject of much controversy in regard to land use possibilities, a closer knowledge of the distribution of its vegetation may help in evaluating this region from the ecological point of view.

The data recorded here and used for the compilation of the map were mainly collected during excursions carried out on foot and by car during the last 7 years.

LOCATION AND TOPOGRAPHY

The area under review is situated in southern Israel between 29°30' and 31°00' N and between 34°20' and 35°30' E. It forms a triangle whose apex points towards the Gulf of Aqaba. In the east and west the area is limited by the Wadi Araba depression and the Egypt-Israel international boundary respectively. The northern limit is along a line running from Auja el Hafir to the southern edge of the Dead Sea.

According to PICARD (1951) this area can be divided geomorphologically into the following regions: (a) Negev Foothills or the down-warped region between Beersheva and Auja el Hafir ranging in altitude from 200m. to 450m. (b) Negev Upland comprising Northern Negev Upland and Central Negev Upland. Certain mountains in the

¹ This paper has been prepared as a part of the research scheme of the Negev Geobotanical Research Laboratory of the J.N.F. and the Hebrew University.

Central Upland (e. g. Ras Rumman, Ras el Khurasha) reach an altitude of 1000m. and more. (c) Sedimentary Southern Negev, the larger part of which consists of rolling gravel plains with average height of 400—500m. (d) Wadi Araba depression, a part of the Syro-African rift valley system, running from the Dead Sea to the Gulf of Aqaba. (e) Southern Crystalline Negev, which is the uttermost NE. corner of crystalline Sinai.

CLIMATE

The Negev is a dry hot desert and its climate is an extreme variety of the Mediterranean type. The limiting ecological factor is moisture. The area dealt with here is situated between the 25-150 isohyets. The annual amount of precipitation decreases from west to east and from north to south. Only in the mountain ranges of Jebel Rumman the annual amount of precipitation is higher, reaching perhaps 200-250 mm. In addition to the scantness of rainfall there is great irregularity in its annual and monthly distribution. As to temperatures, the coldest month of the year is February and the hottest—August. The mean monthly winter temperature in most parts of the area never drops below 10°C.

GEOLOGY

Precambrian crystalline rocks are found in the southernmost part of the Negev (Southern Crystalline Negev). Most common here are granites, micaceous schists and porphyres.

Paleozoic as well as certain parts of the Mesozoic are represented here by the so-called Nubian Sandstone. These sandstone strata are met with in the eroded cores of the big anticlines (Wadi Rumman, W. Hathira, W. Hadira, etc.) and in some places in the Southern Negev.

The greater part of the area is occupied by calcareous formations of the Upper Cretaceous and Eocene (mainly limestones, dolomites, chalks and marls).

Neogenic sediments (mainly sands, clays and conglomerates) are deposited in synclines and depressions.

Quaternary aeolian accumulations of loess and sands are abundant in the Negev Foothills. Wadi Araba is another centre for sand accumulation. Pleistocene Lisan Marl beds are met with in northern Wadi Araba.

SOILS

Calcareous steppe soils (M. ZOHARY, 1947) characterize the less arid areas and are common in the Irano-Turanian territory of the Negev Upland.

Loess soils are found in plains and wadis within the hilly regions of the foothills and upland north of Wadi Rumman and west of a line drawn from Kurnub to 'Abda. These accumulations obviously contain certain amount of fluvial material washed down from the adjacent hills. The greater part of these valleys had been under terrace cultivation by the Nabatean and Byzantine farmers who used to overflow their sown cultures by run-off water from the adjacent hills and wadis. Many were ploughed till recently by local beduins.

Under true desert conditions wind depletion plays a major part in the formation of hammadas which are widely distributed here. Most typical hammadas develop in areas of soft, marly or chalky bedrock. These areas (mainly of Senonian, Lower Eocene and Neogene series) usually have a fairly smooth topography. Huge stretches of these gravel lands are most characteristic of the open rolling landscape of Southern Negev and Wadi Araba. The marl and clay is covered with gravel of various sizes. In many places this soil contains a rather high percentage of soluble salts and gypsum which have not been leached out except in the ephemeral water courses which are the only harbour of vegetation in this region.

Where hard limestones and dolomites occur, typical hammadas are not usually formed. Instead, rocky deserts with rough topography and strong relief prevail.

Considerable areas of Wadi Araba, Traba Valley (5 km. E. of Kurnub) and NW. parts of the Negev Foothills (Khalasa-Auja region) are covered with rather mobile sand dunes and sand fields. Strong dune movement is observed especially in the last mentioned region.

Saline soils occur mainly in the Wadi Araba depression. The Ghor south of the Dead Sea is the richest salty centre here. A muddy saline marsh fed by numerous brackish and saline springs and rivulets occupies the area between the shore of the Dead Sea and the Lisan Marl cliffs 10-15 km. southwards. Saline mudflats or Playas (Qa'as) are met with in the southern part of Wadi Araba, and most of the big springs in Wadi Araba (e. g. Ein Husb, Ein Weiba, Ein Ghadian, etc.) have saline soils in and near their seepage areas.

Apart from the above mentioned hydromorphic salines certain geological formations rich in salt constituents form automorphous salines. The best examples of these are Jebel Usdum with its anhydrite and rock salt and the Lisan Marl "Bad Land" south of the Dead Sea. These are almost devoid of any vegetation and contain large amounts of NaCl and CaSO_4 .

VEGETATION

While the greater part of the area under review belongs phyto-geographically to the Saharo-Sindian region (EIG, 1938) the northern and the western escarpments of the Negev Upland are occupied mainly by the Irano-Turanian vegetation. Sudano-Deccanian enclaves are met with only on the eastern edge of N. Wadi Araba.

The following vegetation units have been distinguished in the area and were marked in the accompanying map.

(i) Irano-Turanian Vegetation

(1) Steppe Forest of *Pistacia atlantica* (No. 1 of the legend)

Several stands and scattered trees of *Pistacia atlantica* Desf. var. *latifolia* DC. are found growing on hillslopes in the most elevated parts of the Central Negev Upland (Ras el Khurasha, Ras Rumman, Jebel Lussan, 900-1000 m. alt.). These stands are limited here to northern and western exposures. A fairly well preserved remnant of this forest type was noted by us near Ras el Khurasha (Plate, III, 1) on a north facing 50%-60% slope. According to its composition it can be tentatively classed under *Pistacia atlantica* — *Rhamnus disperma* assoc. *Pistacia* trees and *Rhamnus disperma* Ehrenb. shrubs are interspaced here by the common components of the *Artemisia* steppe characteristic in these surroundings. The following species associate here with the two above mentioned trees :

Artemisia Herba-alba Asso
Pyrethrum santolinoides DC.
Astragalus bethlehemiticus Boiss.
Eryngium glomeratum Lam.
Colutea istria Mill.

Oryzopsis miliacea (L.)
 Asch. et Schw.
Asphodeline lutea (L.) Rchb.
Varthemia iphionoides? Boiss. et Bl.,
 etc.

Apart from the above mentioned stands which are encountered only in the higher and most humid parts of the Irano-Turanian territory, single trees or groups of *Pistacia atlantica* (in many cases very old trees) are found at the bottom of most of the big wadis within

the Irano-Turanian parts of the Central Negev (e.g. Wadi Nafkh, W. Ajram, W. Butmi, W. Khurasha, W. Lussan, etc.). Few of them penetrate along the wadi beds far into the Saharo-Sindian territory (e.g. Wadi Ided, Bir Birein, etc.).

From the present distribution it seems that the *Pistacia* trees in the whole region are remnants of a particular type of forest which was rather common here during a more humid period of the Pleistocene. The occurrence of some Mediterranean species in this region such as *Fumana thymifolia* and *Oryzopsis miliacea* also testify to this assumption.

(2) *Steppe communities of the Artemision Herbae-albae alliance*
(EIG, 1946; No. 2 and 3 of the legend)

This type of vegetation, confined to calcareous steppe soils, occupies the northern and western parts of the Negev Upland. *Artemisia Herba-alba* is the main component here and together with other associates forms several associations and subassociations. On the N. and NW. escarpments of the Central Negev Upland sagebrush vegetation appears at approximately 600m. altitude.

At 500—600 m. alt. there is a zone of transition between *Zygophylletum dumosi* and the *Artemisia* association with sharp differences between N. and S. exposures. With elevation the sagebrush communities gradually increase both in coverage and in number of Irano-Turanian species present. While at lower altitudes (500-600 m.) the main associates of the *Artemisia* are *Noëa mucronata* (Forsk.) Asch. et Schw., *Reaumuria palaestina* Boiss., *Zygophyllum dumosum* Boiss., etc., at higher altitudes (800-1000m.) typical Irano-Turanian elements, such as *Helianthemum vesicarium* Boiss., *Euphorbia erinacea* Boiss. et Ky., *Stipa Fontanesii* Parl., *S. parviflora* Desf., *Astragalus bethlehemiticus* Boiss., *Rheum palaestinum* Feinbr., *Pyrethrum santolinoides* DC., etc., become more and more abundant, some of them even become co-dominant. This type of sagebrush vegetation strongly recalls in composition and appearance that of Southern Transjordan (Edom). Moreover, certain species first recorded as endemic to Edom occur here.

(3) *Vegetation of the loessy plains*

Within the mountainous and hilly regions of the foothills and upland north of Wadi Rumman there are a series of valleys and wadis in which fluvialite loess soil is deposited. Many of these had been under ancient cultivation and were ploughed till recently by the local Beduins. These valleys are occupied by the following vegetation units:

Within the region of *Artemisia* steppe, above 700 m., *Anabasisidetum Haussknechtii* occupies these loess soils.

It seems that *Anabasis Haussknechtii* Bge. which is here a segetal species, was an important associate of a particular variety of *Artemisia* in which the shallow-rooted sagebrush has been entirely removed by the plough, while the *Anabasis* with its deep root system withstood cultivation.

At altitudes lower than 600-700 m. *Anabasis Haussknechtii* is replaced by *Haloxylon articulatum*. Though it occurs also along with *Artemisia Herba-alba*, the main distribution of *Haloxylonetum articulati* is limited to the valleys already within the region of *Zygophylletum dumosi* which here occupies the hillsides.

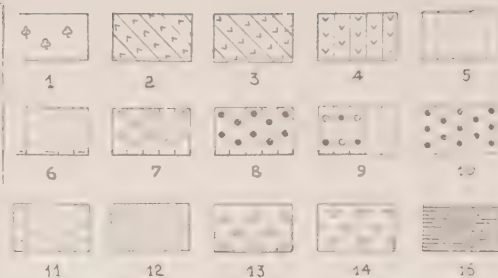
In both above mentioned areas the deeper depressions and ephemeral water courses, where moisture is more abundant, are occupied by belts of *Thymelaea hirsuta* and *Achillea fragrantissima*. In the foothills *Retama Roetam* is very common and associated with *Thymelaea*. Where the valleys are effectively crossed and levelled by ancient terraces, the components of these belts are much more widely distributed.

(ii) *Saharo-Sindian Vegetation*

(1) *Hammada vegetation* (No. 6 of the legend)

The most common association of these huge rolling "gravel deserts" in the Southern Negev and Wadi Araba is *Anabasisidetum articulatae*. Vegetation here is mostly confined to the shallow runnels and water courses intersecting the plains, while the gravel covered areas between them are completely devoid of perennial vegetation (Plate III, 2). Apart from *Anabasis articulata* (Forsk.) Moq., the leading plant of this association, *Anvillea Garcini* (Burm.) DC., *Pulicaria undulata* (L.) Kostel., *Zilla spinosa* (L.) Prantl, *Salsola tetrandra* Forsk., *Asteriscus graveolens* (Forsk.) Less., *A. pygmaeus* (DC.) Coss. et Dur. are very common here.

Where larger wadis cross these areas and where well drained wadi fans occur, the *Anabasisidetum* is more densely populated and also harbours certain Sudano-Deccanian trees and shrubs, such as *Acacia Rad-diana* Savi (= *A. tortilis* Hayne), *A. spirocarpa* Hochst., *Ochradenus baccatus* Del, etc. (Plate III, 3). This association, *Acacietum tortilidis Anabasetosum articulati* (EIG, 1946), by the presence of the above mentioned trees, assumes in certain places of Wadi Araba a savanna-like appearance. Developed *Acacia* stands are found especially along ephemeral water courses which cut the alluvial fans of the main wadis



מפת הצומח של הנגב המרכזי והדרומי

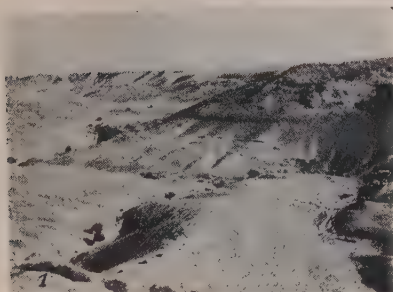
סדרה

1. הרמות האלה האטלנטית במדרונות ההרים (שחור); עצים בודדים לאורך אפיקי נחלים (לבן)
2. ערבות האגד לענת המדבר; בעמקים קרקעות לס מכוסים על ידי חברת היפוקה התלכדנית
3. ערבות האגד לענת המדבר; בעמקים קרקעות לס מכוסים על ידי חברת פוקרק המדבר
4. מדבריות סלעים של חברת הווגן השיחני; בעמקים קרקעות לס מכוסים על ידי חברת פרקרק המדבר
5. מדבריות סלעים של חברת הווגן השיחני (כולל כתמים של 6)
6. אזור מדבריות החמדה; בעיקר חברת היפרוק המדברי (כולל כתמים של 5)
7. אזור חברת הפרקרק הפרסי
8. אזור האגד של 7 ו-8
9. מואיקה של 7 ו-8
10. מואיקה של 5, 7 ו-8
11. חברת המלחת המבאשה
12. צומח החולות של שפלת הנגב
13. מלחות הידרומורפיות
14. מלחות אוטוכטוניות
15. מובלעות סודני-דקניות

VEGETATION MAP OF CENTRAL AND SOUTHERN NEGEV

Legend

1. Stations of *Pistacia atlantica* on mountain slopes (dark); scattered trees along wadi beds (light)
2. Region of *Artemision Herbae albae* steppes; loess valleys occupied by *Anabasis-Haussknechtii*
3. Region of *Artemision Herbae albae* steppes; loess valleys occupied by *Haloxylon-articulati*
4. Region of *Zygophyllum dumosi* rocky deserts; loess valleys occupied by *Haloxylon-articulati*
5. Region of *Zygophyllum dumosi* rocky deserts (incl. patches of 6)
6. Region of hammada vegetation, mainly *Anabasis-articulatae* (incl. patches of 5)
7. Region of *Haloxylon persici*
8. Region of *Haloxylon salicornici*
9. Mosaic of 7 and 8
10. Mosaic of 5, 7 and 8
11. *Salsolium foetidum* assoc.
12. Psammophytic vegetation of the Negev foothills
13. Hydromorphous salines
14. Autochthonous salines
15. Sudano-Deccanian enclaves



1. Remnant of a *Pistacia atlantica* stand along Wadi Nafkh (Central Negev); 2. *Anabasis articulata* in Ghor el Ajram (Wadi Araba); 3. *Acacia tortilis* crossing the hammada plain near Ein Hatzev (Wadi Araba); 4. *Haloxylon persici* in Ein Radian (Wadi Araba).

D. ZOHARY — VEGETATION OF CENTRAL AND SOUTHERN NEGEV

entering Wadi Araba, and outside the seepage areas of some springs occurring here (e. g. Ein Ghadian, Ein Husb, etc.).

Loess material is found in certain flats within the hammada region in Wadi Araba (e. g. Qa'at es Saidiin; No. 11 of the legend). These are not saline due to adequate drainage. *Salsola foetida* is dominant here. In some years these flats are flooded by rain water and ploughed by the Beduins for barley cultivation.

(2) Rocky desert vegetation (No. 5 of the legend)

On more or less steep calcareous rocky slopes *Zygophyllum dumosum* (ERG, 1938) is most characteristic. This association (probably a group of associations) occupies large hilly stretches in the foothill region (Asluj - Subeita - Auja el Hafir area) and on the E. and S. escarpments of the Negev Upland. While in the north *Zygophyllum dumosum* consists of a rather large number of species, it gradually becomes poorer both in number of species and degree of coverage towards south. In the Negev Foothills the wide loessy plains and valleys within the area of *Zygophyllum* are occupied by *Haloxylonetum articulati* (see page 32).

(3) Region of *Haloxylon salicornici* (No. 8 of the legend)

In the southern parts of the Negev *Haloxylon salicornicum* (Moq.) Bge. is a leading plant in several associations. Edaphic conditions are no doubt the main factor of the distribution of these communities. While rare or lacking altogether on calcareous areas, *Haloxylon salicornicum*, together with other characteristic and preferential associates of this alliance, is widely distributed throughout the crystalline and sandstone areas. In contrast, *Anabasis articulata*, *Zygophyllum dumosum* and other leading plants of the calcareous area are almost absent here.

The crystalline and Nubian Sandstone areas of the S. Negev are only the northern outskirts of the huge Arabo-Nubian massif. Phytosociologically this region is as yet inadequately studied and the units given here are only tentative.

The somewhat sandy wadi beds intersecting these areas are occupied by *Haloxylonetum salicornici*. Apart from *Haloxylon*, the common associates here are:

Panicum turgidum Forsk.

Zilla spinosa (L.) Prantl

Iphiona mucronata (Forsk.)

Asch. et Schw.

Daemia tomentosa (L.) Pomel

Tephrosia Apollinea (Del.) Link

Aerva tomentosa Forsk.

Pulicaria undulata (L.) Kostel.

Cleome droserifolia Del.

In this region, too, trees of *Acacia Raddiana* and *A. spirocarpa* occur

in the bigger wadis, together with the above mentioned plants. As in the calcareous hammadas, stands of this unit, *Acacietum tortilidis Haloxylonetosum salicornici* (EIG, 1946), are most developed in alluvial fans of the main wadis entering Wadi Araba.

The ragged crystalline mountains are almost completely barren and vegetation is limited here to fissures and rocky water runnels. Here the following associates are common:

Haloxylon salicornicum
(Moq.) Bge.
Daemia tomentosa (L.) Pomel
Iphia mucronata
(Forsk.) Asch. et Schw.

Abutilon muticum (Del.) Webb
Abutilon denticulatum R. Br.
Lavandula coronopifolia Poir.
Capparis cartilaginea Decne., etc.

(4) *Haloxylonetum persici* (ZOHARY, 1945 ; No. 7 of the legend)

Sand dune accumulations in Wadi Araba are occupied by trees and shrubs of *Haloxylon persicum* Bge. which form here the so-called "Saxaul Forests" (Plate III, 4). Near shallow wadis crossing the sandy areas *Calligonum comosum* L'Hér., *Retama Roetam* (Forsk.) Webb and *Salsola foetida* Del. associate with *Haloxylon*, which may attain here a height of 4-5m. At some distance from the wadis *Haloxylon* is sparse and shrubby. In places with a shallow cover of sand *Haloxylon persicum* grows side by side with *Haloxylon salicornicum* (Moq.) Bge.

(5) *Psammophytic vegetation of the Negev Foothills* (No. 12 of the legend)

The dunes of the Negev Foothills (Khalasa-Auja region) show great similarity to the coastal dune vegetation of Southern Palestine, but harbour several desert psammophytes not encountered in the former region. Most important leading species here are *Artemisia monosperma* Del. and *Aristida scoparia* Trin. et Rupr. Other common associates in this sandy area are:

Retama Roetam (Forsk.) Webb
Convolvulus lanatus Vahl
Cyperus mucronatus (L.) Mab.
Aristida lanata Forsk.
Pennisetum dichotomum
(Forsk.) Del.

Echiochilon fruticosum Desf.
Eremobium lineare (Del.)
Asch. et Schw.
Cutandia memphitica (Spreng.) Bth.
Schimpera arabica Hochst. et Steud.,
etc.

Tamarix articulata Vahl also seems to be native to these sands.

(6) *Saline Vegetation*

The Wadi Araba depression and the Dead Sea basin are the largest centres of halophytic vegetation in the area under review. Vegetation units here were already described by M. ZOHARY (1945). These fall

under two main categories : (a) Hydromorphous salines, (b) Automorphous salines.

Hydromorphous salines (No. 13 of the legend) are most developed in the Ghor plain south of the Dead Sea. The following units have been distinguished here : (a) The muddy plain or "Sebkha" comprising a sterile inundated belt at the shore of the Dead Sea and followed by belt of the *Tamarix tetragyna* — *Arthrocnemum glaucum* assoc. and the *Tamarix maris mortui* — *Suaeda monoica* assoc. (b) The numerous brackish and saline springs and brooks fringed by a vegetation consisting of belts of *Phragmites communis*, *Juncus arabicus*, *Aeluropus littoralis* and sometimes also of *Tamarix maris-mortui*. The belts are not always all represented. (c) A third unit is found near to and above the seepage areas at the foot of the Lisan Marl hills which border the Ghor plain on the south. Associations of *Nitraria retusa*, *Eragrostis bipinnata* and *Prosopis farcata* have been distinguished here.

Hydromorphous salines are also found in Wadi Araba in mudflats or Playas (Qa'as) and in the seepage areas of many of the springs.

Most of the bigger springs in Wadi Araba (e.g. Ein Ghadian, Ein Weiba, Ein Husb, etc.) show the same vegetation belts (or fragments) found at the brackish springs of the Ghor. In some of them the belts of *Eragrostis bipinnata* and *Nitraria retusa* are of considerable width.

The mudflats in southern Wadi Araba are characterized mainly by *Suaedetum monoicae* and *Nitrarietum retusae*; some of them are devoid of plants at their centres.

Attention must also be paid to groups of date palms, *Phoenix dactylifera*, growing in many of the above mentioned salines, especially near springs and among *Eragrostidetum bipinnatae* and *Nitrarietum retusae*. In some places here the local practice is to plant the young palms in holes 1-2 m. deep in order to reach the ground water level and to avoid the highly saline upper strata.

Automorphous salines (No. 14 of the legend). Centres of these are Jebel Usdum with its rock salt and anhydrite; Lisan Marl formations south of the Dead Sea Ghor and the Triassic Gypseous sediments in Wadi Rumman. Jebel Usdum is almost completely sterile. The Lisan Marl "Bad Land" is also sterile but *Salsola tetrandra* is found in some gullies and other favourable localities. In Wadi Rumman too *Salsola tetrandra* scantily covers the ground.

(iii) *Sudano-Deccanian enclaves* (No. 15 of the legend)

These are found on alluvial soils at the outlet regions of fresh water courses and are limited to the north-east corner of Wadi Araba, (e. g. Ghor es Safie, Ghor el Feife). Most important components here are *Zizyphus Spina Christi* (L.) Willd., *Balanites aegyptiaca*, (L.) Del., *Salvadora persica* L., *Moringa apera* Gaertn., *Abutilon muticum* (Del.) Webb, *Abutilon denticulatum* R. Br., *Calotropis procera* (Willd.) R. Br., *Solanum incanum* L., etc.

Department of Botany
Hebrew University
Jerusalem

REFERENCES

- ASHBEL, D. (1951). *Regional climatology of Israel*. Jerusalem. (Hebrew).
 EIG, A. (1938). On the phytogeographical subdivision of Palestine. *Palest. J. Bot. Jerusalem* 1: 4—12.
 — (1946). Synopsis of the phytosociological units of Palestine. *Palest. J. Bot. Jerusalem* 3: 183—248.
 PICARD, L. (1951). Geomorphogeny of Israel. I. The Negev. *Bull. Res. Counc. Israel* 1: 5—31.
 SHAW, S. H. (1947). *Southern Palestine. Geological map with explanatory notes*. Govt. of Palestine.
 ZOHARY, M. (1944). Vegetational transects through the desert of Sinai. *Palest. J. Bot. Jerusalem* 3: 57—78.
 — (1945). Outline of the vegetation in Wadi Araba. *J. Ecol.* 32: 204—213.
 — (1947). A geobotanical soil map of Western Palestine. *Palest. J. Bot. Jerusalem* 4: 24—35.
 — and FEINBRUN, N. (1951). Outline of vegetation of the Northern Negev. *Palest. J. Bot. Jerusalem* 5: 96—114.
 — and ORSHANSKY, G. (1953). Ecological studies in the vegetation of the Near Eastern Deserts. II. Wadi Araba. *Vegetatio*, Haag (In press).

NOUVELLE CONTRIBUTION À L'ÉTUDE DE LA MYCOFLORE DE PALESTINE

(Sixième partie)

PAR T. RAYSS

Reçu Mars 1953

Cette contribution complète ce que nous avons publié sur les Ascomycètes de Palestine. Elle comprend l'étude de 35 espèces dont 22 paraissent dans cette publication pour la première fois ; les autres 13 ont été déjà indiquées par nous mais sur d'autres plantes hospitalières et portent, après le numéro d'ordre, les désignations (I), (II) et (III) se rapportant respectivement à nos publications précédentes, à savoir : (I) SAVULESCU et RAYSS, 1935 ; (II) RAYSS, 1940 et (III) RAYSS, 1947.

Dans l'ensemble de nos publications sur la Mycoflore de Palestine nous avons publié jusqu'à présent 609 espèces de champignons (589 y compris la cinquième partie de cette série de contributions et 20 espèces d'Ustilaginées publiées ultérieurement) ; avec les 22 espèces indiquées ici ce nombre remonte à 631.

Nous indiquons ici un certain nombre de plantes hospitalières nouvelles pour le champignon correspondant et décrivons une variété nouvelle :

Sphaerulina serograpti (Dur. et Mont.) Sacc. var. *calliprinos* Rayss var. nov., attaquant les feuilles de *Quercus calliprinos* Webb dans les maquis de Carmel et de la Galilée et provoquant leur chute prématurée.

PARTIE SPECIALE¹

ASCOMYCETES

EXOASCACEAE

1 (III). *Taphrina coerulescens* Tulasne

Sur les feuilles de *Quercus infectoria* Oliv. UG : Ras-el-Achmar, 27, V. 1949.

Asques : 50-63 x 17-21 μ ; ascospores : 2 μ de diam., plusieurs à l'intérieur de chaque asque.

ASPERGILLACEAE

2. *Aspergillus clavatus* Desm.

Isolé de l'air à Tel-Aviv par R. Barkai-Golan. Forme sur Czapek des colonies

¹ Pour faciliter l'orientation dans les localités citées, nous avons employé des abréviations suivantes : AP-Plaine d'Acre ; CA-Carmel ; CS-Plaine côtière de la Shefela ; GO-Golan ; HP-Plaine de Houleh ; J-Montagnes de la Judée ; N-Negev ; S-Sharon ; UG-Haute Galilée

d'abord blanches, devenant ensuite vert-bleuâtre, Conidiophores 1-2 mm. de hauteur, 25-36 μ de diam.; columelle: 130-170 x 50-60 μ ; Phialides: 7-8 x 2,5-3 μ ; conidies: 3-5 x 2,5-3 μ ; tête conidienne: 200-270 x 120-150 μ , claviforme-allongée.

3. *Eurotium coriorum* Wallr. var. *gelatinicola* Speg.

Sur les os préparés au Laboratoire de Zoologie, Jérusalem. 10. III. 1949. Périthèces: 100-150 μ de diam., jaune-citron, un peu plus foncés avec l'âge, possédant une péricide alvéolaire dont les alvéoles mesurent 17-30 x 15-25 μ . Les périthèces sont disposés sur des filaments hyalins qui deviennent par la suite d'un ochre-cannelle avec un teint vermeil, 3-5 μ de diam, et s'enchevêtrent en formant une espèce de croûte au dessus et autour de périthèces. Asques: 15-20 x 13-19 μ ; spores: 7-9 x 5-8 μ , lisses ou finement verruculeuses. On trouve rarement aussi la forme conidienne-un *Aspergillus* assez mal conservé, au conidiophore de 500-600 x 12-22 μ , tête conidienne: 65-80 μ de diam.; conidies: 6-8 μ de diam.

L'*Eurotium coriorum* a été trouvé en Allemagne et en Italie sur le cuir des souliers dans un lieu humide. La var. *gelatinicola*, qui se distingue de l'espèce type par ses spores plus grandes (7-8 μ de diam. au lieu de 4½-5½ μ), s'est développée en Argentine sur la gélatine glycinée. Notre champignon correspond par tous ses caractères à cette variété.

ERYSIPHACEAE

4 (I.II.III) *Erysiphe cichoracearum* DC. em. Salm.

Sur les feuilles de *Crepis aculeata* (DC.) Boiss. S: Herzlia, 29. III. 1951; CS, Rehovot, 24. III. 1951. Conidies: 24-27 x 12-18 μ ; périthèces: 117-160 μ de diam.; asques: 45-72 x 19-27 μ , stériles.

Sur les feuilles de *Lagoseris sancta* (L.) Maly (= *L. bifida* Koch). CS: Rehovot, 24. III. 1951. Conidies: 26-31 x 12-15 μ ; périthèces: 120-150 μ de diam.; asques: 31-38 x 16-19 μ , jeunes.

5 (I.II.III.) *Erysiphe communis* (Wallr.) Link

Sur les feuilles et les tiges de *Brassica Tournefortii* Gou. CS: Ayanoth, 23.IV.1951; S: Petah-Tiqva, 10.IV.1951; Pardess-Hanna, 27.III.1951. Conidies nombreuses, 33-48 x 12-17 μ ; périthèces très rarement formés, mais alors en masse, 62-96 μ de diam.; asques: 52-60 x 26-32 μ ; spores: 12-24 x 12-17 μ . Plante hospitalière nouvelle?

6 (I.II.III.) *Erysiphe graminis* DC.

Sur les feuilles de *Hordeum bulbosum* L. J: Jérusalem, 12.IV.1951; Motsa, 25.V.1950; CA: Yagur, 18.IV.1950. Périthèces: 180-250 μ de diam.; asques: 70-75 x 32-34 μ , jeunes.

Sur les feuilles de *Hordeum marinum* Huds. (= *H. maritimum* With.) J: Jérusalem, 15.V.1951; coll. D. Zohary. Conidies: 19-28 x 7,5-14 μ ; périthèces: 200-216 μ de diam.; asques: 70-77 x 31-36 μ ; ascospores rarement formées, par quatre dans chaque asque, 9-15 μ de diam.

Sur les feuilles de *Hordeum murinum* L. J. Jérusalem, 2.V.1950, coll. D. Koller: CS: Rehovot, 23. III. 1951; AP: Saint-Jean d'Acre, 3.V.1945. Conidies: 25-35 x 10-13 μ ; périthèces: 175-220 μ de diam.; asques: 80-93 x 32-42 μ , stériles.

Sur les feuilles de *Phalaris paradoxa* L. J: Jérusalem, 15.V.1951, coll. D. Zohary. Conidies: 24-32 x 12-15 μ ; périthèces: 168-190 μ de diam.; asques: 72-84 x 28-35 μ , stériles.

Sur les feuilles de *Poa trivialis* L. S: Pardess-Hanna, 20. III. 1951. Périthèces: 169-210 μ de diam.; asques nombreuses, 68-88 x 26-45 μ stériles.

7 (II). *Erysiphe pisi* DC.

Sur les feuilles et les tiges de *Vicia Faba* L., cultivé dans le jardin de l'Université, 14.VI.1953. Plante hospitalière nouvelle? Conidies : 30-34 (et jusqu'à 40) x 14-16 μ ; périthèces : 100-140 (rarement 160 μ) de diam. (valeurs typiques : 85-126 μ); asques : 60-80 x 35-40 μ (valeurs typiques : 50-60 x 30-40 μ), trois à cinq par périthèce; ascospores rarement formées et encore jeunes, 18-23 x 12-14 μ . (valeurs typiques : 22-27 x 13-16 μ), trois par asque.

Le champignon se trouve sur les deux faces des feuilles, le mycélium est richement formé les périthèces sont rares et apparaissent en juin par petits groupes, lorsque les plantes de *Vicia* sont déjà sèches. Les appendices se trouvent à la base des périthèces, ne se distinguent pas du mycélium et sont plus courts que chez *E. martii*; ils sont quelquefois ramifiés au sommet, ce qui est conforme à la diagnose mais ne sont pas d'un brun intense, comme l'indique la diagnose. Toutes les plantes de notre jardin ont été sévèrement attaquées et se sont vite desséchées.

8 (I.II.III.) *Erysiphe umbelliferarum* de Bary

Sur les tiges, les feuilles et les fruits de *Conium maculatum* L. J : Jérusalem, 22.VI.1950. Conidies : 28-34 x 10-15 μ ; périthèces : 95-110 μ ; asques : 54-60 x 30-38 μ ; spores : 20-25 x 12-15 μ , trois à six par asque.

9 (I.II.III.) *Leveillula taurica* (Lév.) Arnaud

Sur les feuilles d'*Asclepias curassavica* L., cult. J : Jérusalem, 18.XI.1949 leg. Z. Bumstein. Produit des taches de couleur pourpre sur la face supérieure des feuilles; sur la face inférieure sortent par les stomates des conidiophores (5-7 μ de diam.) portant des conidies solitaires du type *Oidiopsis*, 37-68 x 12-17 μ .

Ce champignon a été décrit par SCALIA (1902) en Sicile sur la même matrice sous le nom d'*Oidiopsis sicula* Scalia. D'autre part, HOMMA (apud BLUMER, 1951, p. 109) indique au Japon sur *Asclepias curassavica* un *Ovulariopsis* qui appartiendrait à un *Phyllactinia*.

Sur les feuilles de *Glycyrrhiza glabra* L. J : Jérusalem, 15. X. 1951; GO : Ein-Gev, 4. XI. 1950. Conidies du type *Oidiopsis*, 30-56 x 13-16 μ ; périthèces : 186-216 μ de diam.; asques : 70-80 x 27-40 μ ; spores : 30-40 x 15-17 μ . A été déjà indiqué sur cette matrice au Turkestan. (apud JACZEWSKI, 1927).

Sur les feuilles d'*Impatiens Balsamina* L., hort. J : Jérusalem, 9. IX. 1951. Conidies du type *Oidiopsis*, les conidiophores sortant par les stomates et portant une grande conidie terminale, 48-60 x 12-14 μ .

Sur plusieurs espèces du genre *Impatiens* et aussi sur *Impatiens Balsamina* se trouve dans plusieurs pays un *Sphaerotheca*; nulle part, à notre connaissance, n'est indiqué le *Leveillula*. Ce serait donc une plante hospitalière nouvelle pour ce champignon.

Sur les feuilles de *Lactuca Scariola* L. J : Jérusalem, 8. VIII. 1951. Conidies : 55-68 x 12-15 μ , du type *Oidiopsis*; périthèces : 180-220 μ de diam.; asques : 50-100 x 15-25 μ ; spores : 25-35 x 12-15 μ . Il est curieux que nous ayons trouvé sur cette matrice, à Jérusalem même et à Kiryat-Anavim, aussi l'*Erysiphe cichoracearum* typique; le *Leveillula* paraît être beaucoup plus rare.

Sur les feuilles de *Peganum Harmala* L. N : Revivim, 16. XII. 1949. Conidies : 40-60 x 10-13 , du type *Oidiopsis*. A été indiqué sur cette matrice en Russie méridionale, en Perse et au Kaboul (forma *Pegani* Jacz.).

10. *Phyllactinia suffulta* Sacc. var. *moricola* P. Henn.

Sur les feuilles de *Morus alba* L. J : Jérusalem, forme conidienne le 7. IX. 1951 ; les périthèces en grande quantité apparaissent en novembre, coll. J. Ingster. Conidies du type *Ovulariopsis*, 58-70 (et jusqu'à 100 μ) x 17-24 μ , portées par de longs conidiophores cylindriques, cloisonnés ; périthèces : 150-195 μ de diam. ; asques : 60-82 x 15-30 μ ; spores : 22-30 x 8-18 μ .

Ce champignon, dans son stade imparfait (*Ovulariopsis moricola* Delacroix) a été indiqué en France et au Madagascar (apud JACZEWSKI) ; dans son stade parfait, au Turkestan, dans la région de Ferghana (apud JACZEWSKI) et au Japon (MIYOSHI, apud SACCARDO XVI).

11 (II.III). *Sphaerotheca erodii* Rayss (= *Sph. macularis* Magn. f. *erodii* Jacz.)

Sur les feuilles d'*Erodium gruinum* (L.) L'Hérit. CS : bords de l'Yarkon, 24. III. 1951, coll. N. Haran. Plante hospitalière nouvelle ? Conidies : 21-24 x 12-14 μ ; périthèces : 91-102 μ de diam. ; asques : 60-70 x 48-65 μ ; spores : 17-22 x 10-15 μ , huit par asque.

12. (II). *Oidium dianthi* Jacz.

Sur les feuilles de *Dianthus multipunctatus* Ser. J : Jérusalem, 10. II. 1953 ; S : Hedera, 20. III. 1951. Plante hospitalière nouvelle ? Conidies (du type *Pseud-oidium*) : 15-40 x 7-16 μ . Les exemplaires de Hedera sont fortement attaqués par *Cicinnobolus cesati* de Bary aux pycnides et aux spores un peu plus grandes que ne l'indique la diagnose.

13. *Oidium verbenacae* Pass.

Sur les feuilles de *Salvia verbenaca* L. CA : Wadi Falah, 4. IV. 1943. Conidies : 25-32 x 15-18 μ . Selon Gz. FRAGOSO (1927) ce champignon ne diffère pas suffisamment de l'*Oidium ersiphoïdes*.

14 (II). *Oidium verbenae* Thüm. et Bolle

Sur les feuilles de *Verbena officinalis* L. HP : bords du lac Houleh, 29. V. 1951. Conidies : 22-29 x 12-17 μ . Nous avons trouvé ce champignon sur la même matrice au Liban (Rayss, 1946).

DOTHIDEACEAE

15 (II.III.) *Dothidella trifolii* Bayliss-Elliott

Sur les feuilles de *Trifolium lappaceum* L. AP : Mishmar-ha-Yam, 10. V. 1949, sous le stade conidien-*Polythrincium trifolii* Kunze. Conidiophores : 33-50 x 7-9 μ , spirales ; conidies bicellulaires, 18-22 x 8-11 μ .

CHAETOMIACEAE

16. *Chaetomium elatum* Kunze ex Fries

S'est développé sur le papier-filtre sur lequel ont germé les semences d'*Atriplex nummularia* Lindl. provenant d'Afrique du Sud. J : Jérusalem, 4. III. 1953, leg. A. Cadman. Périthèces très foncées, 400-500 μ de diam., portant des poils latéraux simples, clairs, droits ou légèrement courbés, 4-5 μ de diam. ; les poils terminaux sont robustes, plusieurs fois dichotomiquement ramifiés, 5-8 μ de diam., d'un brun olivâtre et ont leur surface recouverte par des rugosités émoussées ; ils sont entremêlés avec des poils plus minces et pas

ramifiés. Asques éphémères ; spores : $10-13 \times 7-9\mu$, ayant la forme d'un petit citron et la couleur olive.

Cette belle espèce, facilement reconnaissable par ses grands périthèces, ses poils terminaux plusieurs fois irrégulièrement dichotomiques, à surface rugueuse et par ses grandes spores citriformes, a été isolée à plusieurs reprises des semences des plantes variées, au Canada et aux États-Unis (SKOLKO and GROVES, 1948).

17. *Chaetomium erectum* Skolko et Groves

Isolé des toiles pourries par S. Boneh, 15. IV. 1950. Périthèces largement ovales, $125-140 \times 120-125\mu$, vert-foncé à l'état jeune, noircissant avec l'âge. A l'état jeune ils sont pourvus de nombreuses soies latérales, simples, rigides et lisses et ressemblent à des oursins. Par la suite apparaissent en grande quantité les soies apicales, deux à trois fois dichotomiquement ramifiées, à entrenœuds courts, ayant $5-6.5\mu$ de diam. à leur base, foncées et lisses, mais devenant hyalines vers leur extrémité et recouvertes par de petites aspérités au sommet. Les dichotomies sont presque à angle droit. Asques très fugaces, $15-16\mu$ dans leur partie sporifère. Spores : $5.5-7 \times 4-5\mu$, foncées, elliptiques, aux extrémités aigües. Décompose la cellulose d'une façon intense.

Cette espèce, isolée en Amérique des semences de *Petroselinum hortense* Hoffm. en germination, tant que nous le sachons n'a pas encore été trouvée ailleurs.

MYCOSPHAERELLACEAE

18. *Laestadia* (*Guignardia*) *cooperta* (Desm.) Sacc.

Sur les feuilles de *Quercus calliprinos* Webb. UG : Hurfesh, 6. IV. 1940. Périthèces nombreux, noirs, dispersés sur la face inférieure de la feuille, enfoncés dans le parenchyme et recouverts par l'épiderme, $135-170\mu$ de diam. ; asques claviformes, $35-50 \times 9-11\mu$, octosporés ; spores : $6-11 \times 3-4\mu$, ovoïdes-oblongues.

Ce champignon a été indiqué sur les feuilles de *Quercus coccifera* en France (SACCARDO, I : 427) et au Montenegro (BUBAK, 1906).

19. *Mycosphaerella aliena* (Pass.)

Sur les tiges sèches et les capitules de *Centaurea hyalolepis* Boiss. J : Ain-Karem, 14. III. 1949 (en compagnie de *Cladosporium herbarum*). Plante hospitalière nouvelle ? Périthèces : $75-94\mu$ de diam. ; asques : $30-40 \times 7-15\mu$; spores : $8-15 \times 2.5-3\mu$. Les asques de nos exemplaires sont un peu plus grands et surtout plus larges que ne l'indique la diagnose ($30-37 \times 7-8\mu$) ; tous les autres caractères correspondent parfaitement.

20. *Mycosphaerella Cinxia* Sacc.

Sur les feuilles de *Lilium candidum* L. J : Jérusalem, 14. I. 1951, coll. J. Ingster. Périthèces amphigènes, globuleux, noirs, pourvus d'un grand ostiole au centre, $100-150\mu$ de diam. ; asques : $52-125 \times 11-14\mu$; spores : $12-15 \times 5-6.5\mu$. Nos asques sont un peu plus grands que ne l'indique la diagnose ($55 \times 10-11\mu$).

21. *Mycosphaerella cruciferarum* (Fr.) Sacc.

Sur les tiges sèches d'*Hirschfeldia incana* (L.) Lag. Foss. J : Ain-Karem, 14. III. 1949 (en compagnie de *Pleospora herbarum* et d'un *Phyllosticta*). Périthèces : $62-90\mu$ de diam. ; asques : $38-50 \times 10-13\mu$; spores : $10-15 \times 2.5-3\mu$.

22. *Mycosphaerella Tassiana* de Not.

Sur les tiges mortes de *Juncus maritimus* Lam. AP : Mishmar-ha-Yam, 10. V. 1949 Plante hospitalière nouvelle ? Périthèces : 72-96 μ de diam., arrondis, plus ou moins proéminents, munis d'un pore évident au sommet ; asques sessiles, 45-63 x 17-22 μ , aux faces inégales ; spores allongées-elliptiques, cloisonnées vers leur milieu ou bien leur partie supérieure légèrement plus grande, hyalines, 18-24 x 5-7 μ .

23. *Sphaerulina maroccana* Gz. Fragoso

Sur les feuilles de *Trifolium alexandrinum* L., en compagnie d'*Ascochyta trifolii* Bond. et Truss. S : Pardess-Hanna, 20. I. 1950, coll. S. Duvdevani. Plante hospitalière nouvelle. Périthèces : 120-125 μ de diam., à ostiole proéminent ; asques : 55-60 x 27-30 μ ; spores : 27-30 x 12-16 μ , pourvues de trois cloisons transversales et rarement d'une longitudinale. Notre champignon correspond par tous ses caractères à l'espèce de Gz. FRAGOSO décrite sur *Trifolium Bocconi* au Maroc.

24. *Sphaerulina serograptæ* (Dur. et Mont.) Sacc. var. *calliprinos* Rayss, var. nova. A typo differt peritheciis minoribus et ascosporis plerumque 4-septatis.

Sur les feuilles de *Quercus calliprinos* Webb (= *Q. coccifera* L. var. *calliprinos* Webb) CA : Carmel, 15. III. 1938 ; UG : Eilon, 2. IV. 1949 ; Wadi Qarn, 7. IV. 1949. Assez répandu et fréquent. Taches au début rondes et petites, mais s'étendant rapidement et finissant par envahir toute la feuille qui perd alors sa vigueur et tombe au moindre atouchement. Les périthèces, pourvus d'un pore simple et rond, sont hypophylles, au début recouverts par l'épiderme mais la rompant ensuite et la soulevant, sous forme de petits couvercles étoilés. Diamètre des périthèces : 120-150 μ , rarement 180 μ (dans la diagnose de l'espèce typique : 200-220 μ) ; asques : 62-70 x 8-16 μ (dans la diagnose : 70 x 10 μ) ; spores fusiformes-cylindriques, hyalines, droites ou légèrement courbées, pourvues souvent de 4 cloisons transversales (dans la diagnose : 3 cloisons), 26-37 x 2,5-3,5 μ (dans la diagnose : 34-36 x 3 μ).

L'espèce typique a été indiquée sur *Quercus coccifera* en France par CASTAGNE et en Algérie par DURIEU (apud SACCARDO, II : 187). Notre variété en diffère par ses périthèces plus petits et par ses spores qui ont pour la plupart 4 cloisons et non trois.

PLEOSPORACEAE

25. *Leptosphaeria rusci* (Wallr.) Sacc.

Sur les cladodes secs de *Ruscus aculeatus* L. UG : Tarchiha, 6. IV. 1949. Périthèces : 125-180 μ de diam. ; asques : 50-65 x 9-10 μ , à membrane évanescence ; spores : 15-23 x 3-5 μ , pourvues de 4-5 cloisons transversales.

Sur les cladodes de *Ruscus hypoglossum* L., cultivé. J : Jérusalem, 26. VII. 1949, coll. N. Feinbrun. Périthèces : 140-160 μ de diam. ; asques : 75-81 x 10-12 μ ; spores : 24-27 x 4-7 μ , à quatre cloisons transversales.

26. *Leptosphaeria ruscicola* Karst. et Har.

Sur les cladodes putrescents de *Ruscus hypoglossum* L. CS : Ramleh, 28. II. 1949. Périthèces : 190-200 μ de diam. ; asques : 100-135 x 18-20 μ ; spores 25-30 x 6-8 μ , pourvues de trois cloisons transversales ; paraphyses nombreuses, 4-5 μ de diam.

27. (III). *Pleospora asphodeli* Rabenh.

Sur les hampes florifères sèches d'*Asphodelus microcarpus* Viv. N : Kurnub, 17. III. 1947. Périthèces : 130-150 μ de diam.; asques : 80-120 x 20-25 μ ; spores : 22-25 x 10-13 μ , encore jeunes, pourvues de 5-6, rarement 7 cloisons transversales et 1-2 cloisons longitudinales, entourées d'une couche mucilagineuse.

28 (II.III.) *Pleospora herbarum* (Pers.) Rabenh.

Sur les rameaux secs d'*Ailanthus glandulosa* L. S : Nathanya, 21. X. 1948. Périthèces : 250-300 μ de diam.; spores : 27-30 x 12-16 μ , avec 7 cloisons transversales et 1-2 longitudinales.

Sur les tiges sèches d'*Anarrhinum orientale* Bth. J : Ain-Karem, 14. III. 1949. Plante hospitalière nouvelle ? Périthèces : 240-300 μ de diam.; asques : 140-175 x 22-25 μ ; spores : 30-33 x 12-15 μ , avec 7 cloisons transversales.

Sur les bractées et les tiges sèches de *Centaurea hyalolepis* Boiss. J : Ain-Karem, 14. III. 1950. Périthèces : 250-300 μ de diam.; asques : 100-140 x 25-27 μ ; spores : 29-32 x 11-14 μ , à 7 cloisons transversales et 1-2 longitudinales.

Sur les feuilles sèches et les tiges de *Cotoneaster Henryana* Rehd. et Wils., cult. J : Jérusalem, 10. IX. 1948, coll. A. Fahn. Périthèces : 240-300 μ de diam.; asques : 120-160 x 25-35 μ ; spores : 35-40 x 10-15 μ , avec 7 cloisons transversales et 2-3 longitudinales.

Sur les tiges sèches de *Cressa cretica* L. AP : bords de Kishon, 22. VI. 1951, coll. D. Zohary. Périthèces : 240-300 μ de diam.; asques : 120-156 x 19-24 μ ; spores : 20-29 x 9-15 μ , encore jeunes mais déjà avec 7 cloisons transversales.

Sur les feuilles sèches d'*Eryngium maritimum* L. S : Nathanya, 3. IV. 1947. Périthèces : 350-420 μ de diam.; asques : 140-180 (et jusqu'à 230 μ) x 25-30 μ ; spores : 25-33 x 15-18 μ , pourvues de 7 cloisons transversales et 2 longitudinales. Les asques de nos exemplaires sont un peu plus grands que ne l'indique la diagnose (115-165 x 20-30 μ) et sont entourés d'une épaisse enveloppe hyaline.

SAVULESCU et SANDU (1935) indiquent ce champignon sur les tiges d'*Eryngium maritimum* en Roumanie, avec les valeurs typiques.

Sur les tiges de *Launaea nudicaulis* (L.) Hook. Plante hospitalière nouvelle ? N : Bror-Hayil, 13. III. 1950. Périthèces : 230-300 μ de diam.; asques : 100-170 x 20-27 μ ; spores : 31-35 x 12-15 μ , avec 5-7 cloisons transversales et 1-2 longitudinales.

Sur les tiges sèches et les hampes florifères de *Matthiola incana* R. J : Jérusalem, 3. II. 1949. Périthèces : 175-186 μ de diam.; asques : 112-135 x 20-24 μ ; spores : 22-30 x 10-15 μ .

Sur les tiges sèches et les inflorescences de *Micromeria juliana* (L.) Bth. J : Ain-Karem, 14. III. 1949 (en compagnie d'un *Mycosphaerella* et d'une *Dematiacée*). Périthèces : 160-220 μ de diam.; asques : 132-150 x 22-26 μ ; spores : 30-33 x 10-15 μ , pourvues de 7 cloisons transversales et 1-2 longitudinales. Sur cette plante hospitalière est indiqué en Italie *Pleospora media*, à 5 cloisons transversales dans les ascospores.

Sur les tiges et les bractées de l'involucre floral de *Notobasis syriaca* (L.) Cass. J : Ain-Karem, 14. III. 1949. Périthèces : 160-280 μ de diam.; asques : 120-160 x 25-28 μ ; spores : 28-32 x 12-16 μ , avec 7 cloisons transversales et 1-2 longitudinales.

Sur les feuilles vertes de *Pittosporum undulatum* Vent. au centre des taches sèches avec une bordure brune. J : Jérusalem, 3. II. 1949. Périthèces : 175-225 μ de diam.; asques : 162-200 x 25-30 μ ; spores : 30-35 x 12-15 μ , avec 7 cloisons transversales et 2-3 longitudinales.

- Sur les tiges et les bractées sèches de *Silybum marianum* (L.) Gaertn. UG : Tarchiha, 6. IV. 1949 Périthèces : 250-300 μ de diam. ; asques : 125-170 x 24-26 μ ; spores : 27-30 x 12-15 μ .
- Sur les tiges sèches de *Torularia torulosa* (Desf.) Schulz. N. Beersheba, 13. III. 1950. Périthèces : 270-300 μ de diam. ; asques : 100-110 x 25-35 μ ; spores : 30-35 x 13-20 μ , avec 7 cloisons transversales et 1-2 longitudinales.
- Sur les tiges sèches de *Velezia rigida* L. J : Ain-Karem, 14. III. 1949. Périthèces : 180-350 μ de diam. ; asques : 122-125 x 24-25 μ ; spores : 27-30 x 12-15 μ .

29. *Pleospora salicorniae* Jaap

- Sur les tiges sèches de *Salicornia herbacea* L. AP : Naaman, 28. V. 1949. Périthèces épars, à ostiole court, conique, 200-350 μ de diam. ; asques : 150-175 x 30-33 μ ; spores : 25-35 x 12-15 μ , à 7 cloisons transversales et 1-2 longitudinales, de couleur jauné-miel.

Ce champignon a été décrit en Allemagne sur *Salicornia herbacea* et retrouvé en Roumanie sur la même matrice (Herbarium Mycologicum Romanicum, XXVII, No. 1318). Notre champignon en diffère légèrement par la dimension de ses spores (24-28 x 12-13 μ chez JAAP, 24-33 x 7-12 μ chez SAVULESCU et SANDU) ; tous les autres caractères correspondent complètement.

CLYPEOSPHAERIACEAE

30. *Anthostomella italica* Sacc. et Speg.

- Sur les feuilles de *Saccharum biflorum* Forsk. CS : bords de l'Yarkon, 4. IX. 1951. Plante hospitalière nouvelle. Périthèces enfoncés dans le tissu de la feuille, 180-240 μ de diam. ; asques : 85-90 x 10-15 μ ; spores : 15-20 x 6-8 μ , pourvues d'un court appendice, fuligineuses.
- Ce champignon a été décrit en Italie sur *Saccharum strictum* Spreng.

TUBERACEAE

31. *Pseudobalsamia microspora* Diehl et Lambert

- UG : Matsuba, dans les champignonnières, 15. IX. 1949. Coll. S. Kohn. Ascocarpes à surface cérébroïde, 0,5-2,5 cm de diam., de couleur crème-brunâtre à texture serrée vers l'extérieur, plus lâche et alvéolée au centre ; asques fugaces, 18-20 x 12-15 μ , contenant 8 spores rondes, 6-8 μ de diam., hyalines, lisses, avec une grosse goutte d'huile au centre. Ce concurrent dangereux du champignon de couche—aussitôt paru—a été énergiquement combattu et n'a plus été retrouvé depuis.

HUMARIACEAE

32. *Discina venosa* Pers. (= *Disciotis venosa* Boudier)

- CA : Haifa-Carmel, bois des pins, sur la terre, 10. IV. 1950, coll. R. Koppel. Réceptacles sous forme d'une coupe globuleuse devenant étalée par la suite, 3-4 cm de diam., à hyménium plissé et veiné ; pied court, épais, aux côtes saillantes. Asques : 250-300 x 12-15 μ ; spores : 22-25 x 12-13 μ .

VELENOVSKY (1943) donne pour les exemplaires récoltés par lui en Bohême, les dimensions de 8 à 20 cm, valeurs qui ne sont jamais atteintes par nos champignons. Nos exemplaires ont été dessinés en couleur par Ruth Koppel dans notre petite flore illustrée des champignons (RAYSS et REICHERT, 1951).

PLICARIACEAE

33. *Plicaria muralis* Sow.

Sur la terre humide dans les pots où on a cultivé *Begonia*, J : Jérusalem, 21. VI, 1951, coll. D. Zohary. Réceptacles sous forme d'assiette aux bords recourbés, 4 cm de diam., de consistance charnue, transparents, de couleur ochre-chamois, légèrement poilus et blancs au dessous ; pied large et très court ; asques bleuissant par l'iode, surtout vers leur extrémité 165-280 x 12-15 μ ; spores elliptiques, lisses, incolores, uniséries, 14-17 x 8-9 μ ; paraphyses filamenteuses, élargies à leur sommet jusqu'à 6-8 μ . D'après Rehm (1896), les réceptacles sont de 1-3 cm., d'après VELENOVSKY (1934) de 2 à 6 cm.

34. *Plicaria violacea* (Pers.) Fuck.

J : Jérusalem, sous les *Pinus halepensis*, 15.V.1947 Réceptacles de couleur violet-pourpre, devenant brun-violacé avec l'âge, atteignant 2 cm. de diam. ; asques : 150-175 x 6-12 μ , bleuissant par l'iode ; spores : 10-12 x 5-6 μ , elliptiques, hyalines, renfermant à la maturité deux gouttelettes d'huile ; paraphyses étroites à la base (1-2 μ de diam.), s'élargissant vers le sommet jusqu'à 5 μ , devenant bruns et se recourbant sur les asques.

34. *Plicaria violacea* (Pers.) Fuck.

CA : Carmel, sur un sentier dans un bois de pins, 16. II. 1952, coll. A. Cadman. Réceptacles de 8 à 10 cm de diam. ; face extérieure blanchâtre ou rougeâtre ; la couche hyméniale d'un violet sale. Asques : 310-320 x 14-15 μ , bleuissant par l'iode ; spores elliptiques, 13-18 x 8-10 μ , pourvues généralement de deux gouttelettes d'huile.

D'après VELENOVSKY (1934) les réceptacles de cette espèce peuvent atteindre les dimensions de 22 cm.

Department of Botany
Hebrew University
Jerusalem

BIBLIOGRAPHIE

- BLUMER, S. (1933). Die Erysiphaecen Mitteleuropas. Beitr. Kryptogamenflora Schweiz, VIII. Zürich.
- BUBAK, Fr. (1906). Zweiter Beitrag zur Pilzflora von Montenegro. Bull. Herb. Boissier (2-ème série), No. 5 : 393-408 ; No. 6 : 473-488.
- Gz. FRAGOSO, R. (1927). Estudio sistematico de los Hifales de la Flora Española. Mem. R. Acad. Madr. ser. 2a, T. 6.
- JACZEWSKI, A. A. (1927). Karmanii opredelitel Gribov. II. Lenin-grad (en russe).
- RAYSS, T. (1940). Nouvelle contribution à l'étude de la Mycoflore de Palestine (Deuxième partie). Palest. J. Bot. Jerusalem 1 : 313-335.
- RAYSS, T. (1946). Contribution à la flore mycologique du Proche Orient. Bull. Soc. mycol. Fr. 62 : 5-41.
- RAYSS, T. (1947). Nouvelle contribution à l'étude de la Mycoflore de Palestine. (Quatrième partie). Palest. J. Bot. Jerusalem 4 : 59-76.
- RAYSS, T. and REICHERT, (1951). Some mushrooms of Palestine. Coloured plates by Ruth Koppel. (In Hebrew).

- REHM, H. (1896). Ascomyceten (Hysteriaceen und Discomyceten). *Rabenhorst's Kryptog. Flora*, I.III Abt.
- SAVULESCU, Tr. et RAYSS, T. (1935). Contribution à l'étude de la Mycoflore de Palestine. *Ann. Cryptog. exot.* 8 : 49-87.
- SAVULESCU, Tr. et SANDUVILLE, C. (1935). Beiträge zur Kenntnis der Micromyceten Rumäniens, *Hedwigia* 75 : 159-233.
- SCALIA, C. (1902). Di una nuova malattia dell' *Asclepias curassavica* Spr. — *Oidiopsis sicula*. *Agricoltore calabro-sic.* 27.
- SKOLKO, A. J. and GROVES, J.W. (1948). Notes on seed-borne Fungi. V. *Chaetomium* species with dichotomously branched hairs. *Canad. J. Res. C.* 26 : 269-280.
- VELENOVSKY, J. (1934). *Monographia Discomycetum Bohemiae*. Pars I et II, Pragae.

THE EFFECT OF 2,4-D AND COUMARIN ON RESPIRATION OF GERMINATING WHEAT AND LETTUCE SEEDS *)

BY RUTH LEVARI

Received March 1953

INTRODUCTION

This study represents one stage of a research undertaken in order to clarify the physiological action of some germination inhibitors. Germination has generally been considered as a single process, instead of regarding it as a result of a number of different processes acting concurrently or successively. In addition, much of the evidence on the physiological effect of germination inhibitors is contradictory despite wide investigation, because material, treatment and experimental conditions have been diverse. Plant material has been found by various authors to react differently at even slightly different ages (ALBAUM and EICHEL, 1943 ; COMMONER and THIMANN, 1941). In order to avoid these disadvantages it was decided to define the different processes at the various stages of germination, and to study the influence of the inhibitors upon them during the time of germination at the effective concentrations.

The process of respiration during germination was chosen as the first step of this investigation, because it may serve as a guide in future experiments, being at the same time a result and a cause of various metabolic activities. Only very few data are found in literature which deal with respiration in the initial stages of germination and with the effect of the inhibitors during that time.

METHODS

Seeds of lettuce and wheat, which contain entirely different reserve materials, were chosen for this study. The wheat was of the local Nursi variety of the 1951 crop, the lettuce used was of the variety Progress**) which is not light sensitive at the temperature used (26° C.). The inhibitors chosen were 2,4-D and coumarin. The first because of its effectiveness and practical importance, the second because of its interesting and complex physiological effects as regards the photoblastism and temperature sensitivity of some seeds.

*) This work is part of a Ph. D. thesis to be submitted to the Hebrew University, Jerusalem.

**) We are greatly obliged to Mr. Frank Cuthbertson, President of the Ferry—Morse Seed Co., for supplying the seeds.

Parallel experiments were carried out with the two kinds of seeds, treated with 2,4-D or coumarin. Three concentrations of the inhibitors were chosen according to their effect on germination, causing (a) no marked inhibition, (b) approximately 50% inhibition (c) 100% inhibition of germination.

200 mg. lettuce seeds and 0.2 ml. of water or inhibitor were placed in Warburg respirometer flasks and placed in a thermostat at 26° C. for the desired length of time. The flasks were enclosed in containers having a water vapour saturated atmosphere, to prevent evaporation. For wheat 1 gr. of seeds were germinated in petri dishes on filter paper, with 5 ml. of liquid. This difference in method was unavoidable because of the difference in the size of the seeds. The amounts of liquid used were found to be optimal for germination in a preliminary experiment.

Respiration measurements were made in a Warburg respirometer at 26° C. using the "Direct Method" with 0.2 ml. of 20% KOH in the central well. The respiration of the seeds at the end of one hour in the respirometer at different time intervals after the seeds were germinated was estimated. No further liquid was added to the lettuce seeds before respiration measurements, whilst wheat was transferred to the flasks with 0.5 ml. of the liquid in which they were germinated. No buffer was added for reasons stated by MAYER and EVENARI (1953).

QO_2 and QCO_2 were calculated as the amount of absorption or evolution of gas in μ l. per 100 mg. of air-dried seeds of lettuce and for 1 gr. of air-dried seeds of wheat. For each set of different concentrations and different time intervals parallel flasks were set up. Each experiment was repeated three times. The three concentrations of the same inhibitor and a water control were run simultaneously. In order to estimate the effect of the inhibitors, the respiration for different treatments was also calculated as a percentage of the respiration of the water control. The significance of the mean difference between the value in water and in the various treatments was calculated by "Student's method for correlated samples", since only experiments taken at the same time were paired.

RESULTS

(i) *Wheat*

QO_2

Water (Figs. 1 and 2). In water a steep rise in oxygen absorption up to the 4th hour is noted, which slackens until the 10th hour, and then regains its former rise.

2,4-D. The concentrations chosen for 2,4-D according to their effect on germination, as mentioned previously, were 100, 500 and 1000 p. p. m. Here (Fig. 1), an even steeper rise in O_2 absorption can be observed until the 4th hour. With the increase in concentration the retardation of the rise is more pronounced. At no time interval measured does the curve regain its former slope. The maximum increase in relation to water occurs during the 4th hour, it then decreases at the 6th hour and shows a slight upward trend at the 8th hour. From the 10th hour onward oxygen absorption is markedly inhibited.

Coumarin. The concentrations chosen for coumarin were 25, 75 and 250 p. p. m. The effect of coumarin (Fig. 2) differs only slightly from

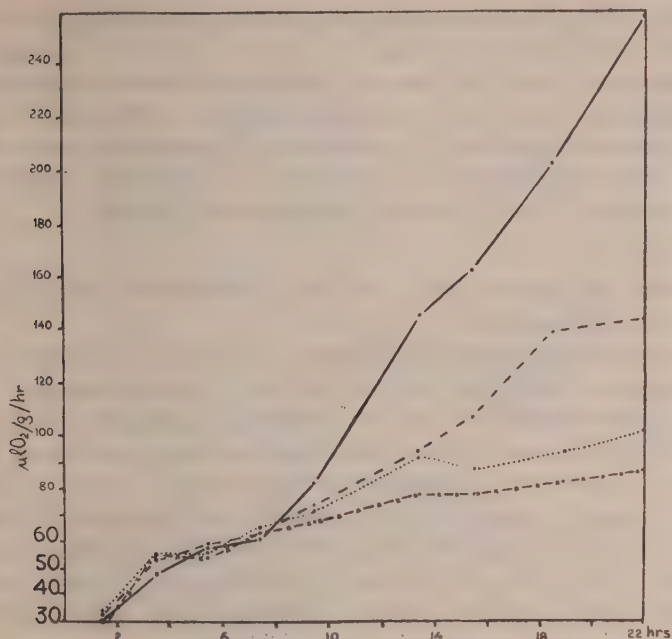


Fig. 1.

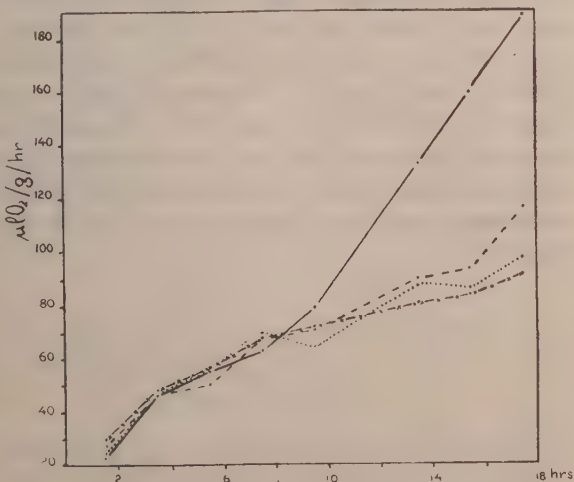
O₂ absorption by wheat in water and in 2,4-D

- water
- - - 2,4-D conc. 100 p. p. m. (no inhibition)
- 2,4-D conc. 500 p. p. m. (50 % inhibition)
- x - x - 2,4-D conc. 1000 p. p. m. (100 % inhibition)

Fig 2.

O₂ absorption by wheat in water and in coumarin

- water
- - - coumarin conc. 25 p. p. m. no inhibition)
- coumarin conc. 75 p. p. m. (50 % inhibition)
- x - x - coumarin conc. 250 p. p. m. (100 % inhibition)



that of 2,4-D. The main differences are that the maximum increase appears already at the 2nd hour, and that it is highest for the highest concentration. At the 4th hour no significant difference is perceptible as compared with water. The second maximum at the 8th hour is more pronounced and significant. The intensity of O_2 absorption, as compared with water and expressed in percentages, is about 10% higher in coumarin than in 2,4-D, both at stimulation and inhibition.

QCO_2

Water. The increase of CO_2 evolution is almost linear and is higher than the O_2 absorption.

2,4-D. Here the same trends appear as for oxygen absorption but the stimulation during the 2nd and 4th hour is more pronounced.

Coumarin (Table 1). The CO_2 evolution in coumarin does not essentially differ from that of O_2 absorption, except that during the 4th and the 6th hour the decrease of CO_2 evolution as compared with water is generally significant. In O_2 absorption no significant difference can be found. The highest concentration differs from the other concentrations in that during the 4th hour it stimulates CO_2 evolution, while the others already inhibit it. After the 14th hour there is again a positive correlation between concentration and inhibition.

R.Q.

Water. The R.Q. values for water in Fig. 3 show a certain amount of divergence. This may be due to variations in material and external conditions. In general it can be concluded, however, that the quotient rises from a value near unity during the 2nd hour up to about 1.35 at the 8th hour, and declines to 1.1 at the 22nd hour.

2,4-D (Figs. 3 and 4). During the 2nd hour the R.Q. is much higher in 2,4-D than in water. This difference decreases between the 4th to the 10th hour. The two lower concentrations have an even lower value than water. After 13 hours the R.Q. in 2,4-D increases again as compared with water, and rises with the increase in concentration (Fig. 4).

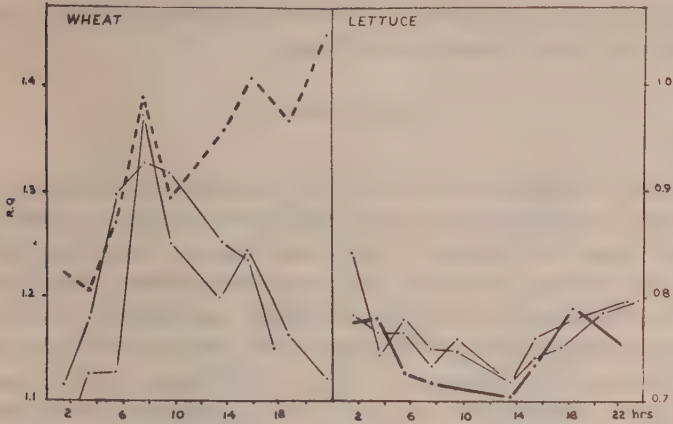


Fig. 3.

Respiratory Quotient
Water (2 replicates)
--- 2,4-D conc. 1000 p. p. m.
— coumarin conc. 100 p. p. m.

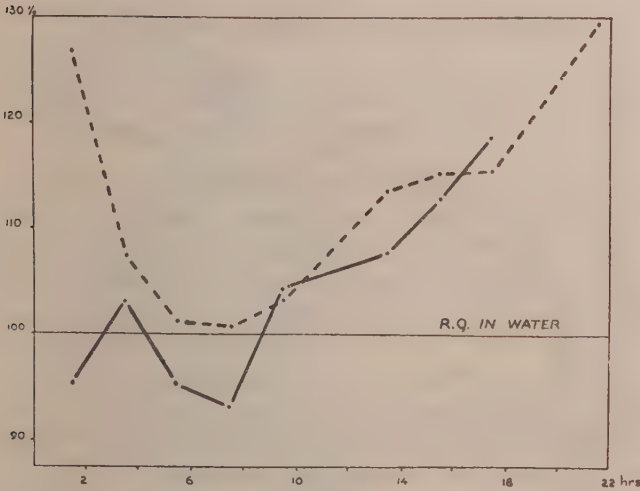


Fig. 4.

The effect of the inhibitors upon R. Q. in wheat expressed as percentage of water control

--- 2,4-D conc. 1000 p. p. m.
— coumarin conc. 250 p. p. m.

Coumarin. Comparing the R.Q. in coumarin with that in water (Fig. 4), it appears that up to the 8th hour there is a tendency to a lowering

of the R.Q. During and after the 10th hour this changes into a marked increase of the R.Q. above that of water.

(ii) Lettuce

QO_2

Water. Comparison of the curves in water in Figs. 5 and 6 shows that they are essentially the same, but differ in the time at which the various stages are reached. In both cases there is a steep rise in O_2 absorption up to a maximum. This maximum, however, lies between the 8th—10th hour and the 10th—14th hour respectively. It is followed by a retardation in the O_2 absorption at the 14th or 16th hour. After this minimum the curve regains its former slope. Lettuce seeds in general show great variability with regard to their germination over a period of time (MAYER, 1953). Data for Fig. 5 were collected during April—May and for Fig. 6 in July.

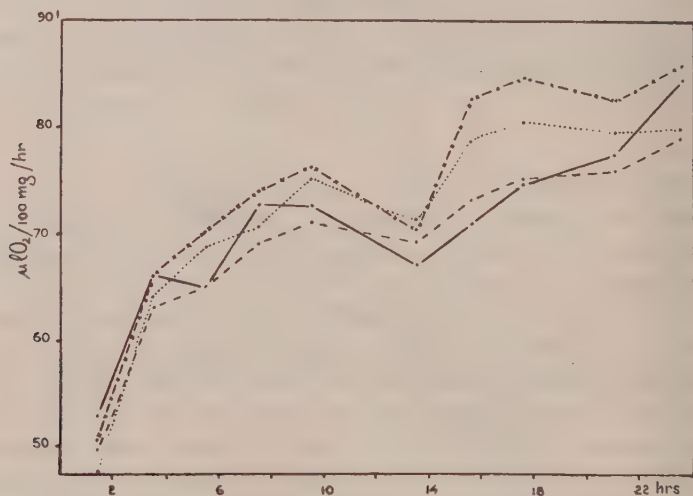


Fig. 5.

O_2 absorption by lettuce in water and in 2,4-D

- water
- - - 2,4-D conc. 10 p. p. m. (no inhibition)
- ... 2,4-D conc. 25 p. p. m. (50 % inhibition)
- .x—x—x. 2,4-D conc. 50 p. p. m. (100 % inhibition)

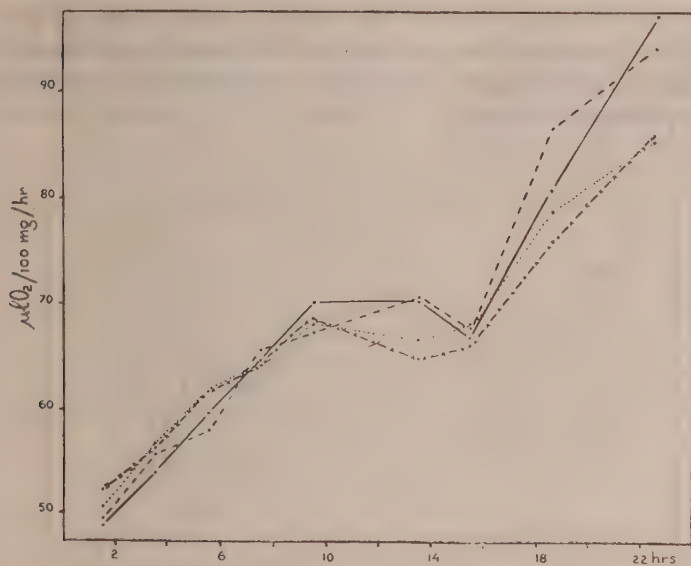


Fig. 6.

O₂ absorption by lettuce in water and in coumarin

- water
- - - coumarin conc. 10 p. p. m. (no inhibition)
- . . . coumarin conc. 50 p. p. m. (50 % inhibition)
- x—x—x. coumarin conc. 100 p. p. m. (100 % inhibition)

2,4-D. The concentrations chosen for lettuce seeds were 10, 25 and 50 p. p. m. During the 2nd and 4th hour 2,4-D inhibits O₂ absorption, later this is replaced by a stimulation as compared with water until after the 18th hour. Later on no further marked increase in O₂ absorption in 2,4-D was noted. The intensity of oxygen absorption increases with the concentration.

Coumarin. The concentrations chosen here were 10, 50 and 100 p. p. m. The effect of coumarin upon oxygen absorption is the reverse of that of 2,4-D. Fig. 6 shows a stimulation at the beginning, which is followed by an inhibition as compared with water. The minimum is reached at the 14th hour (in the water control at 16th hour). The lowest concentration shows some divergence. With increasing concentrations the O₂ absorption decreases.

QCO₂

Water. The CO₂ evolution is smaller than the O₂ absorption. The rise and fall in intensity is similar.

2,4-D. The effect of 2,4-D upon QCO_2 is very similar to that of QO_2 . The inhibition during the 2nd and 24th hour, and the stimulation at the 6th and the period from the 14th to 18th hour are, however, more pronounced (Fig. 7).

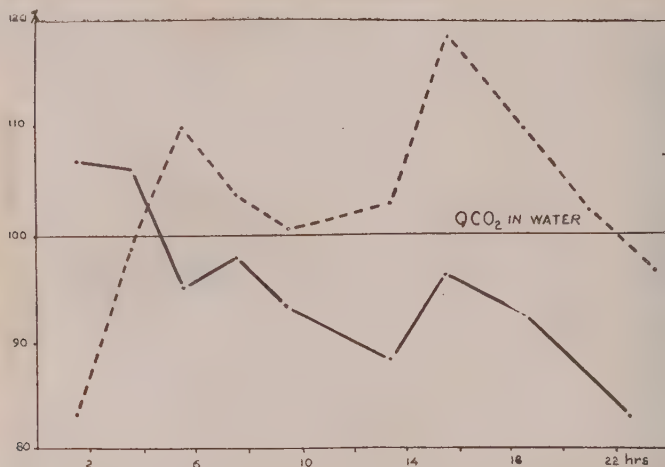


Fig. 7.

The effect of the inhibitors upon CO_2 evolution in lettuce, expressed as percentage of water control

----- 2,4-D conc. 50 p. p. m.

———— coumarin conc. 100 p. p. m.

Coumarin. Here, as for 2,4-D the effect of the inhibitor upon QO_2 and QCO_2 is similar. The inhibition from the 6th hour is more pronounced.

R.Q.

Water. The R.Q. of two curves obtained at different times (Fig. 3) differs during the 2nd hour. In both curves the quotient falls from 0.84 or 0.79 to 0.72 at the 14th hour after which it rises up to 0.79 after 24 hours.

2,4-D. The effect of 2,4-D on R.Q. is generally to lower it as compared with water. Those cases where it is above the R.Q. in water were found to be statistically non-significant.

Coumarin. Here, too, the general trend is towards a lowering of the R.Q. (Fig. 3). As in the case of 2,4-D this decrease, which is statistically significant, amounts to less than 10%.

DISCUSSION

In drawing conclusions from the results obtained in this study, we are handicapped by the fact that little is known about the metabolic processes occurring, even in water, during germination at the short intervals measured. For this research respiration measurements were taken only until a few hours after the radicle is discernible in water, which is equivalent to about 16 hours after germination in lettuce and to about 15 hours for wheat. The results of our experiments confirm the findings of COMMONER and THIMANN (1941), that respiration is less sensitive to inhibitors than growth, as respiration was inhibited only slightly in concentrations where no perceptible germination occurred.

Seeds with different reserve material were chosen for this study. Wheat represents the typical starch seed, while fat is the main reserve in lettuce. It is a well known fact that, beside starch, fat and protein are present in small quantities in the wheat grain. During the first day of germination their amount diminishes slightly. On the other hand POLJAKOFF-MAYBER (1953) found a small amount of sucrose in dry lettuce seeds. This sucrose disappeared 24 hours after germination. The amount of sucrose found in dry lettuce seeds of variety Grand Rapids needed for its oxidation exactly the same amount of oxygen as was absorbed by these seeds during 24 hours of germination. In variety Progress the oxygen absorption during the first 24 hours of germination was higher than the amount needed for oxidation of the sucrose present in the dry seeds. It may, therefore, be concluded, that while in Grand Rapids the substrate for respiration during that time is entirely sucrose, in Progress another substrate beside sucrose is respired. These conclusions of POLJAKOFF-MAYBER are further confirmed by the fact that the R.Q. for Grand Rapids during that period is about unity (EVENARI, personal communication), while in Progress the value varies between 0.7 and 0.8.

The response of the different seeds to any one inhibitor may be due to the fact that the reaction involved occurs at different times and to a different extent in wheat and in lettuce.

Wheat

From the intensity of respiration of germinating wheat in water, the existence of three distinct phases in development of the seed may be deduced. A similar division into phases of respiration was made by STILES and LEACH (1932) in the respiration of germinating *Lathyrus odoratus*. We found during the second phase, 4th to 10th hour, a

retardation of the increase of respiration intensity as compared with the first and third phase. The phases differ in their response to the inhibitors.

Both 2,4-D and coumarin increase respiration slightly as compared with water, during the first phase. Various authors found a positive correlation between the moisture content in seeds and their respiration. The increase in respiration during the first phase may be due to an increase in hydration of the tissues by the inhibitors. Their effect on permeability towards water has been studied by von GUTTENBERG and BEYTHIEN (1951) in epidermal cells of *Rhoeo*. Coumarin inhibits permeability in high concentration but on dilution there is no reversal to stimulation. 2,4-D was without effect. The effect of 2,4-D on germination was found by LEVARI, MAYER and EVENARI (1952) to be increased by the addition of various amino acids. In red kidney beans treated with 2,4-D SELL et al. (1949) found an increase in the amount of protein, and its amino acid composition was changed by 2,4-D. From this it appears that 2,4-D affects protein metabolism. LEVARI et al. (1952) concluded that the effect is probably one of acceleration of some part of protein metabolism, which may account for the increased respiration in the first phase.

During the second phase the increase of respiration in water slows down; while there is no appreciable effect of the inhibitors on respiration. The third phase begins at about the 10th hour. This phase is characterized by growth. The first external evidence for it is the rupture of the seed coat, at about the 15th hour. Whilst a steep rise in respiration intensity occurs in water, no such increased rise can be found in the presence of the inhibitors. The increased respiration in water can be accounted for by the increased activity of the embryo due to its growth. No marked rise occurs in the inhibitors as the embryo fails to develop. It can, therefore, be concluded that inhibition of respiration from the 10th hour onward is a result of inhibition of development and not the cause of inhibition of germination.

From Fig. 3 it may be concluded that the main difference between R.Q. of seeds germinated in water and in the inhibitors occurs after the initial rise till the 10th hour. In water the R.Q. then declines until its initial value is reached, while in the inhibitors the R.Q. continues to rise. In the R.Q. as in respiration intensity the inhibited seeds fail to pass into the third phase, which seems to characterize developing seedlings. By the 10th hour the fate of the seeds seems, therefore, already

to have been decided. During the first phase the effects of the inhibitors differ, probably due to their different action on the metabolism.

The raising of the R.Q. by 2,4-D is not as pronounced as it would be if the effect of 2,4-D were to cause anaerobic conditions in metabolism of germinating wheat, as was proposed by HSUEH and LOU (1947). On the contrary, to marked effect of 2,4-D upon the R.Q. is perceptible during the second phase, which seems to be the critical time prior to growth.

Lettuce

Respiration of lettuce seeds in water can be divided into the same phases as that of wheat, but the onset of the various phases is generally delayed. The first phase continues for 8 to 10 hours, and like in wheat, the respiration is greatly increased. This is followed by a phase in which the increase in respiration is suspended and it even decreases during the 14th or the 16th hour, at the end of which germination becomes apparent. The reason for this sudden decrease is not known. The third phase is characterized by a steep rise in respiration immediately after this minimum.

No correlation between physiological activity and respiration intensity during germination can be found in lettuce as in spite of slight inhibition or stimulation, the respiration in the inhibitors is similar to that in water. The decrease in the respiration rate and the sharp rise following is not related to growth, since it also occurs in the inhibitors, where no growth is discernible. A sample experiment conducted during the 48th hour showed an extraordinary inhibition of respiration as compared with water, and even no marked increase of respiration in the inhibitors occurred as compared with that of the 24th hour.

The two inhibitors affect respiration in opposite directions. Coumarin stimulates respiration until after the 6th hour, and then inhibits it. 2,4-D on the other hand, inhibits respiration until after the 4th hour and later stimulates it. Stimulation in 2,4-D and inhibition in coumarin are highest at the highest concentrations.

The problem is made more intricate by the fact that they affect the R.Q. in precisely the same way. The low level of the R.Q. in water (0.7—0.8), which is typical for utilization of fat, is difficult to understand, as sucrose has been found to be one of the substrates respired during the first 24 hours.

As mentioned previously, we are greatly handicapped by the fact that little is known about the metabolic processes active during germi-

nation of the seed even in water. Therefore a thorough examination of the metabolism during that time is essential for further explanation of the action of the inhibitors upon these processes.

SUMMARY

Respiration of germinating wheat and lettuce seeds in water, 2,4-D and coumarin was studied. The concentrations used were those which inhibited germination of wheat and lettuce respectively.

1) The respiration in water during the time intervals measured may be divided into three phases according to its increase in intensity.

2) In wheat, both 2,4-D and coumarin stimulate respiration during the first phase, have no marked effect during the second phase and inhibit respiration during the third phase.

3) The R.Q. in water was found to be about unity during the 2nd hour. It reaches a maximum of 1.35 at the 8th hour and falls to 1.1 at the 22nd hour.

4) The quotient is lowered by coumarin and raised by 2,4-D during the first phase. It is raised by both during the third phase.

5) Respiration of lettuce in water differs from that of wheat in that the second and third phases occur later with lettuce. A temporary decrease in the intensity of respiration of lettuce is found at the end of the second phase.

6) 2,4-D first inhibits and stimulates later, whilst the effect of coumarin is exactly the opposite.

7) The R.Q. in water is about 0.8 during the 2nd hour; it falls to a minimum of 0.72 at the 14th hour and rises again to 0.795 during the 24th hour.

8) The quotient is slightly lowered by 2,4-D and coumarin.

An attempt was made to indicate which processes cause the changes in respiration of germinating wheat which are due to the effect of the inhibitors.

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to Professor Evenari for his constant interest and helpful criticism during this investigation. Thanks are also due to Dr. Poljakoff-Mayber and Dr. Mayer for their advice and help with the manuscript.

Department of Botany
Hebrew University
Jerusalem

REFERENCES

- ALBAUM, H.G. and EICHEL, B. (1943). Relationship between growth and metabolism in oat seedlings. *Amer. J. Bot.* 30 : 18-22.
- BAILEY, C. H. (1940). Respiration of cereal grains and flaxseed. *Plant Physiol.* 15 : 257-274.
- COMMONER, B. and THIMANN, K. V. (1941). On the relation between growth and respiration in *Avena coleoptile*. *J. gen. Physiol.* 24 : 279-296.
- EVENARI, M. (1949). Germination inhibitors. *Bot. Rev.* 15 : 153-186.
- and NEUMANN, G. (1952). The germination of lettuce seed. II. The influence of fruit coat, seed coat and endosperm upon germination. *Bull. Res. Council, Israel* 2 : 75-77.
- GUTTENBERG, H. v. and BEYTH- IEN, A. (1951). Ueber den Einfluss von Wirkstoffen auf die Wasserpermeabilität der Protoplasma. *Planta* 40 : 36-69.
- HSUEH, Y. L. and LOU, C. H. (1947). Effects of 2,4-D on seed germination and respiration. *Science* 105 : 283-285.
- LEHMANN, E. und AICHELE, F. (1931). *Keimungsphysiologie der Graeser*. Stuttgart.
- LEVARI, R., MAYER, A. M. and EVENARI, M. (1952). The effect of various metabolites on the action

- of some germination inhibitors, *Bull. Res. Counc. Israel* 1 : 27-36.
- MAYER, A. M. (1953). Quantitative aspects of the behaviour of coumarin as a germination inhibitor, *Physiol. Plant.* 6 : 413-421.
- and EVENARI, M. (1951). The influence of two germination inhibitors (coumarin and 2,4-D) on germination in conjunction with thiourea and cysteine. *Bull. Res. Counc. Israel* 1 : 125-129.
- and — (1953). The activity of organic acids as germination inhibitors and its relation to pH, *J. exp. Bot.* 4 : 257-263.
- NICKELL, L. G. (1950). Effect of certain plant hormones and colchicine on the growth and respiration of virus tumor tissue from *Rumex acetosa*, *Amer. J. Bot.* 37 : 829-835.

GERMINATION INHIBITORS AND PLANT ENZYME SYSTEMS

II. DEHYDROGENASES

BY ALEXANDRA POLJAKOFF-MAYBER

Received June 1951

In a previous publication (POLJAKOFF-MAYBER, 1952) the action of coumarin as a germination inhibitor was investigated. After determining that it has direct effect on the catalase system, we decided to investigate the dehydrogenases in germinating lettuce seeds and the inhibiting effect of coumarin on germination with the purpose of determining the relation, if any, between these systems.

Various dehydrogenating enzymes are of general occurrence in seedlings and germinating seeds. Plant acid dehydrogenases and purine derivative dehydrogenases have been demonstrated in starchy seeds (FODOR and FRANKENTHAL, 1930). In fatty seeds, fatty acid dehydrogenases have been found (GRANDE, 1934). Reductase was found in proteinaceous *Lupinus* seeds (MACHT and BRYAN, 1937). REUHL (1936) worked with fatty and starchy seeds. She found that while starchy seeds lacked a "hydrogen donor — dehydrogenase" system, fatty seeds were in possession of a complete system of this type. In some of these, e.g. *Brassica*, this system proved to be active even before germination, while in *Linum* and others it started functioning only during germination.

As lettuce seeds are of the fatty type, it was decided to test light-sensitive lettuce seeds for the presence of a "donor-enzyme" system of the type mentioned and to investigate the effects of light and coumarin on the activity of such systems.

METHODS

Seeds of lettuce of a light-sensitive variety, Grand Rapids, were used throughout the experiments*. The seeds were germinated as previously described (POLJAKOFF-MAYBER, 1952).

* We wish to express our thanks to Messrs. Ferry-Morse Seed Co., San Francisco, for kindly supplying the seeds.

The dehydrogenase activity was determined by visual measurements of the rate of reduction of methylene blue in ordinary test tubes after incubating at 26°C for 24 hours, as described by REUHL (1936).

The results were expressed by means of the following scale :

± Week reduction

+ Complete decolourization at the base of the tube

++ Complete decolourization of up to $\frac{1}{2}$ of the tube

++ Decolourization throughout at least $\frac{2}{3}$ of the tube

As nothing at all was found in the literature about the dehydrogenases of lettuce, it was believed that even the facts found during this preliminary work were worth publishing. They are to be followed by more precise experiments.

EXPERIMENTAL

The dehydrogenase activity of germinating lettuce seeds was estimated after various germination times. Whole seedlings and seedling extracts were used in parallel. The results are summarized in Table 1.

TABLE 1
Dehydrogenase activity of lettuce seedlings of various ages

Ages of seedlings	Intensity of methylene blue reduction	
	Whole seedlings	Extracts
Air dry seeds	—	—
Germinated 1 hr.	—	—
" 3 hrs.	—	—
" 7 hrs.	—	—
" 18 hrs.	+	+
" 24 hrs.	+	+
" 48 hrs.	++	++
" 72 hrs.	+++	+++
" 96 hrs.	+++	+++

As is evident from Table 1, the "donor-enzyme" system does not function until the 18th hour after placing the seeds in water. This is also the time when the radicle emerges from the seed coat. The question arose whether up to this time it is the donor or the enzyme which is missing. Various donors were chosen for investigation. Tests were carried out to determine their action on the dehydrogenases of extracts prepared from 48-hours old seedlings and their effect on the decolourization time of methylene blue. The results are summarized in Table 2.

TABLE 2

Effect of various substances on decolourization time of methylene blue by extracts of 48-hrs. old lettuce seedlings

Substance *	Incubation period				
	3 hrs.	6. hrs.	8 hrs.	10 hrs.	24 hrs.
Oleate	—	—	—	—	+
Stearate	—	—	—	—	++
Oxalate	—	—	—	—	+
Succinate	—	—	—	—	+
Tartrate	—	—	—	—	++
Citrate	—	—	+	++	+++
Maleate	—	—	—	—	+
Crotonate	—	—	—	+	++
Salicylate	—	++	++	++	+++
Cinnamate	—	++	++	++	+++
Nicotinic acid	—	—	—	—	—
Aq. dest.	—	—	—	+	++

* All the acids were used as their sodium salts. The final concentration in all cases was 50 mg. %.

Citric, salicylic and cinnamic acids were found to increase the dehydrogenase activity of the seeds. Citric acid was the only of these substances which can be regarded as a suitable hydrogen donor. From the substances listed in Table 2 only maleic acid is not a natural plant acid. Crotonic, salicylic and cinnamic acids were active as germination inhibitors. Nicotinic acid is generally considered to be a part of the dehydrogenase coenzyme.

Citric, salicylic and cinnamic acids were used in further experiments in order to determine their ability to stimulate the "donor-enzyme" system in the early stages of germination, prior to its natural inception of activity. The results were negative. The "donor-enzyme" system could not be induced to function before the 15th—17th hour after germination.

In order to obtain an approximate idea of the relative activity of the system in various parts of the seedling, extracts were made from entire roots, hypocotyls, cotyledons and whole 72-hours old seedlings. Their activity was estimated after an incubation period of 24 hours. The results are given in Table 3.

TABLE 3
Dehydrogenase activity of various parts of the seedling

Part of seedling	Enzyme activity
Whole seedlings	+++
Cotyledons	+
Hypocotyls	—
Roots	++

It will be seen that roots show the highest dehydrogenase activity.

The *in vitro* action of 10mg.% coumarin, as a germination inhibitor, and 125mg.% thiourea as a dormancy-breaking substance, was investigated. The results are given in Table 4.

TABLE 4
In vitro action of coumarin and thiourea on dehydrogenase activity of seedlings of various ages

Substance	Dry seeds	Germination period	
		24 hrs.	48 hrs.
Aq. dest.	—	+	++
Thiourea	—	+	++
Coumarin	—	+	++

The seeds were germinated in coumarin and thiourea respectively, and the activity of their "donor-enzyme" systems was tested by the usual method. The results are shown in Table 5.

TABLE 5
Dehydrogenase activity of lettuce seeds germinated in water, coumarin and thiourea, in darkness and with light stimulus

Treatment	After 24 hrs.		After 48 hrs.	
	% germ.	Activity	% germ.	Activity
Water — light	90	+	95	++
Water — darkness	10	+	17	+
Coumarin — light	—	—	0	—
Thiourea — light	95	+	95	+
Thiourea — darkness	25	+	37	+

DISCUSSION

A "hydrogen donor — dehydrogenase" system of the type described by

REUHL (1936) for seeds of *Brassica* and *Linum* has been shown to exist in lettuce seeds of the variety Grand Rapids. The system becomes active 15 to 18 hours after the immersion of the seeds in water, at about the time when the radicle emerges from the seed coat. The activity of the system increased markedly after 48 hours of germination, when, according to GRIFFITH (1930), the fat reserves in the seed are getting low. It could, therefore, be expected that the fat is converted either into fatty acids or into plant acids, which in turn act as hydrogen donors.

The absence of the "donor-enzyme" system activity before the 15th hour of germination could be due either to the absence of a suitable hydrogen donor or to the lack or inactivity of the enzyme. In order to clarify this point, various substances were tested as hydrogen donors. The only substances which were effective in stimulating the "donor-enzyme" system were citric, cinnamic and salicylic acids. All three have been classed by EVENARI (1949) as germination inhibitors. Of these, citric acid alone may be considered as a hydrogen donor. Cinnamic and salicylic acids seem to act as activators of some sort rather than as hydrogen donors. Nicotinic acid showed a marked inhibitory effect. As neither oleate nor stearate were effective, it is probably not the fatty acid dehydrogenases which are involved in this "donor-enzyme" system.

The three acids which were effective in shortening the methylene blue decolorization time were ineffective in activating the "donor-enzyme" system prior to the 15th hour of germination. If a suitable hydrogen donor fails to induce the activity of dehydrogenase prior to the 15th hour of germination, it might be assumed that the enzyme is either missing or bound in some inactive form. However, as indicated by EVENARI (1952), measurable respiration exists prior to the 15th hour. Therefore, the existence of dehydrogenases must be assumed, even though this could not be shown by the method used. This point requires further investigation.

Of the various parts of the seedling, the radicle possesses the highest dehydrogenase activity. This is in agreement with the fact that the dehydrogenase activity of the seedling is not pronounced unless the radicle has attained a considerable size. This is contrary to the observations on *Lupinus* by MACHT and BRYAN (1937) and on *Avena* seedlings by BERGER and AVERY (1943), in which the roots were always the least active part, the cotyledons or the first leaf being the most active.

In vitro, coumarin did not affect the "donor-enzyme" system at all.

In vivo, it prevented germination from proceeding normally and attaining the stage at which the system becomes active. Therefore, the latter cannot be considered as a direct effect on the enzyme. But as nothing definite is as yet known about the condition of the enzyme in the seeds prior to the 15th hour of germination, no definite conclusions can be drawn as to the effect of coumarin on the dehydrogenating enzymes in the germinating seed.

Thiourea, *in vivo*, although stimulating germination in the dark, prolongs the decolourization time of methylene blue and does not stimulate the "donor-enzyme" system. This makes it improbable that the stimulating effect of thiourea on germination is brought about by its effect on the dehydrogenases.

SUMMARY

(1) Germinating lettuce seeds which had reached the stage of root emergence exhibited a "hydrogen donor — dehydrogenase" system. This system was lacking in earlier stages of germination.

(2) The decolourization time for methylene blue was shorter in the presence of the sodium salt of citric acid.

(3) Sodium salts of oxalic, tartaric, succinic, oleic and stearic acids did not affect the decolourization time.

(4) None of the acids tested could induce the activity of the above system in the earlier stages of germination.

(5) Coumarin *in vitro* had no influence on the "hydrogen donor — dehydrogenase" system. *In vivo*, it prevented the seeds from reaching the stage at which the above system begins to function.

(6) Thiourea had no effect on the above system either *in vivo* or *in vitro*.

Department of Botany
Hebrew University
Jerusalem

REFERENCES

- BERGER, J. and AVERY, G. S. Jr. (1943). Dehydrogenases of the *Avena* coleoptile. *Amer. J. Bot.* 30 : 290—297.
- EVENARI, M. (1949). Germination inhibitors. *Bot. Rev.* 15 : 152-194.
- (1952). Private communication.
- FODOR, A. and FRANKENTHAL, L. (1930). Ueber das Hydrierungsvermoege von Getreidesamen in Anwesenheit von Pflanzensaehren und Purinsubstanzen als Wasserstoffdonatoren. *Biochem. Z.* 225 : 417—425.
- GRANDE, F. (1934). Ueber das Vorkommen von Palmitico — und Stearico—dehydrogenasen in einigen Pflanzensamen. *Skand. Arch. Physiol.* 69 : 189-196.
- GRIFFITH, A. E. (1938). Observations on the germination of lettuce seeds. *Contr. Boyce Thompson Inst.* 9 : 329—337.
- MACHT, D. I. and BRYAN, H. F. (1937). Relative potency of reductase in dry, wet and germinated *Lupinus albus* seeds. *Amer. J. Bot.* 24 : 133—134.
- POLJAKOFF-MAYBER, A. (1952). Germination inhibitors and plant enzyme systems. I. Catalase. *Bull. Res. Council, Israel* 2 : 239-245.
- REUHL, E. (1936). Notes on metabolic changes in the germination of seeds. *Rec. Trav. bot. néerl.* 33 : 1—76.

ISOLATION OF SOIL ORGANISMS ANTAGONISTIC TO SOME PHYTOPATHOGENIC FUNGI

BY MARGALITH KATZ

Received March 1953

INTRODUCTION

The equilibrium between competing organisms of the soil microflora is of much interest to the crop grower. Since some of the organisms, such as plant pathogens, are harmful, while others, such as their antagonists are beneficial to crop production, a thorough investigation of the relations between pathogens and their antagonists under controlled conditions is desirable.

The antipathogenic properties of the antagonists are mainly due to their production of antibiotic substances. There are several experimental ways of combating pathogens by antibiotics: (1) Pure antibiotics may be used as sprays, dusts or seed desinfectants, as described by HAMPTON (1948), ARK (1947), and Mc KEEN (1949). (2) The normal equilibrium prevailing in the soil can be disturbed, creating more favourable conditions for the antagonists. This may be achieved by inoculation of the soil with known antagonists (ANWAR, 1949), or by changing soil conditions through the application of manure (GROSSBARD, 1951).

The work to be described was designed to test the antibiotic influence of some naturally occurring soil organisms on three pathogenic fungi.

MATERIAL AND METHODS

The pathogens used in these experiments two strains of *Rhizoctonia solani*, one isolated from flax seedlings, the other from an infected potato tuber, and *Spondylocladium xyloenum* and *Alternaria* sp. also isolated from flax seedlings. The pathogenicity of the latter two is doubtful, and therefore they were used only in part of the experiments.

The antagonists were isolated from soil suspensions. Suspensions of various soils, diluted 1:10000, were incubated at 25–27°C. on Czapek's agar and potato dextrose agar. After four to six days colonies of bacteria, fungi and actinomycetes could be distinguished on the medium. Upon these colonies suspensions prepared from spores of the pathogenic fungi were poured, or in the case of *Rhizoctonia solani* parts of mycelium spread out. The fungi expanded rapidly over the whole surface of the culture medium, but the appearance of zones of inhibition indicated the presence of an antibiotic organism. This was isolated and subcultured until pure cultures were obtained. Tests of the antibiotic action were carried out by streaking the pure cultures against the cultures of the pathogens (Fig. 1).

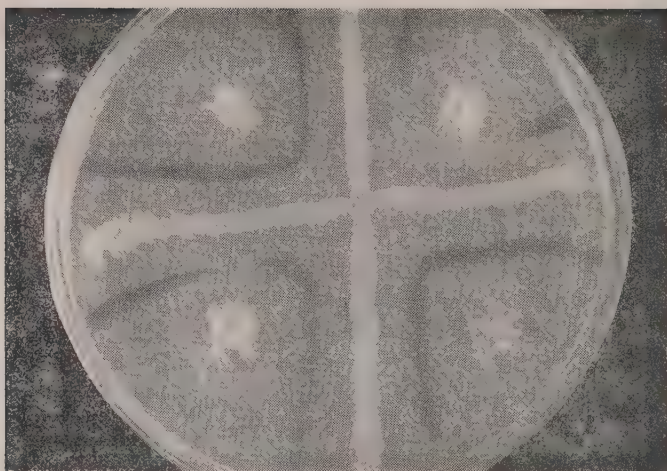


Fig. 1.

Inhibition of *Rhizoctonia solani* by *Bacillus subtilis*

In order to test the inhibitory action of the antibiotic organisms on an infected plant, further experiments were carried out in pots and in Erlenmeyer flasks. The pots were filled with sandy loam, and sterilized at 160° C. for twelve hours. The soil was inoculated with pieces of potato dextrose agar on which a pure culture of the pathogenic fungus had been grown for forty eight hours. In each experiment twelve pots were used. These were divided into four groups, and each group given a different treatment (see Tables 1 and 2). The flax seeds were sown at a depth of 15 mm., 80 seeds in each pot. The percentage emergence was determined by counting the seedlings after the appearance of the first two true leaves. In a second series of experiments the seeds were germinated in 250 cc. Erlenmeyer flasks, 20 seeds per flask, upon sterilized cottonwool. Inoculation and treatment were the same as in the pots. Here only fully germinated seeds were considered.

The protection of the seedlings by the antibiotic organisms was carried out in two ways :

(1) A suspension of the antibiotic organism was added to the substrate simultaneously with the seeds and with the pathogenic fungus (Pre-treatment A).

(2) Prior to sowing, the flax seeds were immersed for twenty four hours in a suspension of the antibiotic organism (Pre-treatment B).

RESULTS

Among a group of organisms with antibiotic properties, isolated from soil by the methods described, two were particularly efficient against phytopathogenic fungi. One, an actinomycete, was isolated from the vicinity of *Spondylocladium xyloenum* (Fig. 2), the other, later indentified as *Bacillus subtilis*, was received from Dr. I. Wahl, who

discovered it adjacent to a culture of *Rhizoctonia solani* during the isolation of the latter from flax seedlings. Further investigations of these two organisms were undertaken.

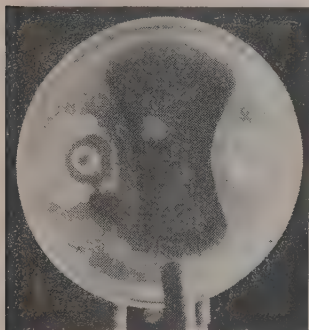


Fig. 2.
Inhibition of *Spondylo-*
cladium xylogenum by
Actinomyces diastaticus

The actinomycete was sent to Prof. Baldacci of the University of Milano and was identified as *Actinomyces diastaticus* Krainsky. It is characterized by a solid colony, 2-3 mm. in diameter, when cultured on potato dextrose agar. During the first days of its growth, the colony is white, but it turns grey after about one week. The colony consists of sporing hyphae, forming spirals at their distal ends. On being placed in water, these spirals break up into oval spores. Although first isolated from Czapek's agar, the organism could not subsequently be grown on this substrate. This behaviour indicates that its initial growth on Czapek's agar was due to the presence of accessory substances from the original soil suspension. Pure cultures of this actinomycete grow well on potato dextrose agar and on various bacteriological media containing peptone and salts.

Besides being active against *Spondylocladium xylogenum*, *Actinomyces diastaticus* also affected the growth of *Alternaria* sp. and of the two strains of *Rhizoctonia solani*. *Rh. solani* formed a wide ring of sclerotia at the edge of the zone of inhibition (Fig. 3). Sclerotia were also obtained when the fungus was grown under unfavourable conditions, such as low temperature, a thin layer of the nutrient medium, etc.

Bacillus subtilis, too, proved to be active against both strains of *Rh. solani*.

In order to test the effect of the antagonistic organisms on flax seedlings infected with *Rh. solani*, (the strain isolated from flax



Fig. 3.

Inhibition of *Rhizoctonia solani* by *Actinomyces diastaticus* and the ring of sclerotia formed by *Rhizoctonia*, adjacent, to the zone of inhibition.

seedlings), two series of experiments were conducted, differing in the time of application of the antibiotic organisms (Pre-treatments A and B respectively). The results differed as will be seen from Tables 1 and 2.

TABLE 1

The effect of *Actinomyces diastaticus* and *Bacillus subtilis* on the seedling emergence of flax seed under various treatments (Pre-treatment A)

Treatment	% seedling emergence (80 seeds sown)
Control	31.2
+ <i>Rh. solani</i>	25.0
+ <i>Rh. solani</i> + <i>A. diastaticus</i>	10.0
+ <i>Rh. solani</i> + <i>B. subtilis</i>	38.3

As may be seen from Table 1, the percentage of seedling emergence of infected seeds, when treated with *Bacillus subtilis*, was 13.3% higher than in the case of untreated seeds, and 7% more than in the uninfected controls. This may be explained by the fact that various saprophytic fungi, such as *Mucor*, *Penicillium* and *Aspergillus*, developed on the untreated soil, but failed to develop on the treated soils. It seems, therefore, that saprophytes also exert some inhibitory action on germinating seeds. Further, it may be seen that where the soil was treated with *Actinomyces diastaticus*, the latter did not depress the pathogen. Apparently the growth of *Rh. solani* is much more rapid than that of the actinomycete, so that it depresses the inhibitory action of the latter.

However, the antagonistic action of *A. diastaticus* on *Rh. solani* and on the above-mentioned saprophytic fungi may be seen from Table 2.

TABLE 2

The effect of *Actinomyces diastaticus* on the seedling emergence of flax seed under various treatments
(Pre-treatment B)

Treatment	% seedling emergence (80 seeds sown)
Control	28.1
+ <i>Rh. solani</i>	10.0
+ <i>Rh. solani</i> + <i>A. diastaticus</i>	25.5

The results obtained show that when pre-treatment B was applied, the increase of seedling emergence of infected seeds was 15.4% and that of uninfected controls 54.7%.

From the comparison of Tables 1 and 2 it may be concluded that only when the infected seeds were immersed, prior to sowing, in the suspension of *A. diastaticus* (pre-treatment B) does the latter effect antibiotic activity on the pathogenic fungus. When the suspension of the antibiotic organism is applied simultaneously with sowing (pre-treatment A), *Rh. solani*, the growth of which is more rapid than that of *A. diastaticus*, attacks the seedlings before the protective action of the actinomycete can be exerted.

With flax seeds germinated in Erlenmeyer flasks (see material and methods) similar results were obtained.

Comparison of the effect of antibiotic organisms with the effect of Panogen, a synthetic disinfectant produced by the Casco Co., Sweden, applied during the germination of seeds infected with *Rh. solani* (GALUN, 1953), showed that in the case of Panogen the increase of seedling emergence was only 13.5%, i.e. the antibiotic organisms are much more effective in protecting the infected plants.

SUMMARY

The antibiotic effect of two organisms isolated from soil, *Actinomyces diastaticus* and *Bacillus subtilis*, on three phytopathogenic fungi, *Spondylocladium xyloenum*, *Alternaria* sp. and two strains of *Rhizoctonia solani* was studied. Tests were conducted in vitro and in soil. Particular attention was given to the study of the effect of the antibiotic organisms on the emergence of flax seedlings from seeds infected with *Rh. solani*. The antibiotic organisms proved to be effective in raising the percentage of seedling emergence from infected seeds.

ACKNOWLEDGEMENTS

This work was carried out under the supervision of Prof. T. Rayss to whom I wish to express my sincerest thanks for her continued help and interest throughout this research. Thanks are due also to Prof. E. Baldacci for the identification of our actinomycete.

Department of Botany
Hebrew University
Jerusalem

REFERENCES

- ANVAR, A. A. (1949). Factors affecting the survival of *Helminthosporium sativum* and *Fusarium lini*. *Phytopathology* 38 : 1005-1019.
- ARK, P. P. (1947). Effect of crystalline streptomycin on phytopatogenic bacteria and fungi (Abstr.) *Phytopathology* 37 : 842.
- GALUN, E. (1953). *The effect of mechanical injury, seed treatment, soil types and soil microorganisms on the germination of flax seeds in Israel*. M. Sc. Thesis, Rehovot.
- GROSSBARD, E. (1951). Antibiotics and microbial antagonism in plant pathology. *Endeavour* 10, 39 : 145-150.
- HAMPTON, J. E. (1948). Cure of crown gall with antibiotics (Abstr.) *Phytopathology* 38: 11-12.
- MC KEEN, W. F. (1949). A study of sugar beet root in southern Ontario. *Canad. J. Res., C*, 27 : 284-311.

הנשימה של החסה נבדלת מזו של החיטה בזה כי הופעת השלבים מתאחרת, וחלה ירידה זמנית בעצמת הנשימה בסוף השלב השני. 2,4-D מזרז בתחילה את הנשימה ואחר כך מעכבה. פעולת הקומרין היא הפוכה מהנ"ל. מקדם הנשימה במים הוא בערך 0.8 במשך השעה השנייה, ויורד ל-0.72 בשעה ה-14 ושוב עולה ל-0.8 בשעה ה-24. שני המעכבים מורידים במקצת את מקדם הנשימה.

מעכבי נביטה ומערכות אנזימטיות צמחיות II. דהידרוגנזות

מאת אלכסנדרה פוליקוב-מיכר

בזרעי חסה נובטים, שהעבר הגיע בהם לשלב בו בולט השורשון מהזרע, נעלת מערכת של "דונטור מימן — אנזים", שאינה פעילה בדרגות נביטה קודמות. זהויה של מערכת זו מתאפשר על ידי כושרה לחזר את הצבע של כחול מתילן.

מלחי נתרן של חומצת הלימון בחומצה הקנמית והחומצה הסליצילית מקצרים את הזמן הדרוש לחזור הצבע של כחול מתילן.

מלחי נתרן של החומצה האוקסלית, הסוקסינית, חומצת היין, החומצה האולאית והחומצה הסטיארית אינם משנים את אורך זמן החזור.

החומצה הניקטינית מאריכה את הזמן הדרוש לחזור הצבע של כחול מתילן. אף אחת מהחומצות שניסנו אינה מעוררת את פעילותה של מערכת דהידרוגנזות בזרעים הנמצאים בדרגות נביטה מוקדמות.

הקומרין במבחנה אינו משפיע על פעילות מערכת דהידרוגנזות; אך *in vivo* הוא מונע בעד הזרעים מלהגיע לאותה דרגת התפתחות בה מערכת זו מופעלת באופן טבעי.

תיאוראיה אינה משפיעה על פעילות דהידרוגנזות, לא במבחנה ולא *in vivo*.

בדוד אלו אורגניזמים שהם אנטיביוטיים לגבי פטריות פיטופתוגניות

מאת מרגלית כץ

נבדקה השפעה אנטיביוטית של שני אורגניזמים אשר בודדו מן הקרקע *Actinomyces diastaticus* ו- *Bacillus subtilis* על שלוש פטריות פיטופתוגניות, *Rhizoctonia solani* ושני גזעים של *Alternaria* sp., *Spondylocadium xylogenum*. הנסויים נעשו *in vitro* ובאדמה. תשומת לב מיוחדת נתנה להשפעת האורגניזמים האנטיביוטיים על הצצת נבטי פשתה מזרעים הנגועים ב- *Rhizoctonia solani*. הוכח כי האורגניזמים האנטיביוטיים מעלים את אחוזי ההצצה.

(5) צומח החולות של הנגב הצפוני דומה בכללו לזה של חולות חוף-הים בצפון אלא שכאן הוא מאופיין על ידי כמה צמחים ראשיים. כגון מלעגן המטאטאים. הזיפוצה המדוקרנת, חבלבל הצמר וכו'.

(6) עמק הערבה ואגן ים המלח הם המרכזים הגדולים ביותר לצומח ההלופילי באזור הנבדק. המלחות הובדלו כאן להידרומורפיות ולאוטומורפיות. הראשונות כוללות את חברת האשל והבן-מלח. חברת האשל הצרפתי והאוכט החד-ביתי, חברת הימלות, החילף וכו'. המלחות האוטומורפיות הן עקרות בעיקרן. רק בבתרים של חור-הלשון בדרומו של ים המלח וכן גם בודי דמון מצויים במחלות אלו בני-שיח של המלחית הקשקשנית.

(7) המובלעות הסודר-דקניות מוגבלות לאזורי השפך של נהרות איתן אשר בע"ז אל צפי וע"ז אל פיפה. הצמחים החשובים ביותר כאן הם השיוח המצוי, הזקום המצרי, הסלודורה הפרסית, המורינגה הרתמית וכו'.

תוספת חדשה להכרת הפטריות של ארץ-ישראל

(חלק שני)

מאת ט ש ר נ ה ר י י ס

במאמר זה מובאות תוצאות המחקר על פטריות הנאדית (Ascomycetes) שנאספו לאחר פרסום העבודות הקודמות.

22 מינים נמנים כאן בפעם הראשונה: יחד עם מיני הפטריות שפרסמנו אותם בעבודות הקודמות מגיע מספר המינים של הארץ אשר הוגדרו על ידינו ל-631.

מתוארת צורה חדשה של פטריה טפילית על עלי האלון המצוי *Sphaerulina serograpti* (Dur. et Mont.) Sacc. var. *calliprinos* Rayss, var. nov. פטריה זאת נאספה בחורשות הכרמל והגליל העליון והיא גורמת לנשירת עלי האלון.

השפעת 2,4-D וקומריין על נשימת זרעים

נובטים של חיטה וחסה

מאת רות לבארי

נחקרה נשימת זרעי חיטה וחסה אשר הונבטו במים. ב-2,4-D ובקומריין. רכוזי המעכבים שבהם השתמשנו היו כאלה המעכבים את הנביטה באפן חלקי. באפן מוחלט וכאלה שאינם משפיעים על הנביטה. בהתאם לעצמת הנשימה נתן לחלק את התקופה שבין ההנבטה לראשית הנביטה לשלושה שלבים.

בחיטה מוזרים 2,4-D וקומריין את הנשימה בשלב הראשון, ומעכבים אותה בשלב השלישי. מקדם הנשימה במשך השעה השניה לאחר ההנבטה קרוב ליחידה. בשעה השלישית הוא מגיע למקסימום של 1.35 ויורד בשעה ה-22 ל-1.1. בשלב הראשון הקומריין מוריד את מקדם הנשימה ואילו 2,4-D מעלה אותו. אולם בשלב השלישי שני המעכבים גורמים להעלאת מקדם הנשימה בהשוואה למים.

זרעי ובין העצים מופיעים כאן מרכיבים של חברת לענת המדבר, גם בגיאיות של הר הנגב, כגון ודי נפה, ודי אג'ר, ודי בוטמי וכר, מצויים עצים בודדים או קבוצות עצים של האלה האטלנטית.

(2) צומח ערבתי של אגד לענת המדבר (*Artemision Herbae albae*). אגד זה מכיל חברות אחדות. בעוד שמגובה 600 מ' ואילך מאוכלסים הרמות והמורדות של הנגב המרכזי צומח טפוסים של חברת לענת המדבר, הרי בגובה נמוך יותר קיים אזור מעבר בין צומח זה ובין הצומח של הזוגן בו תופס צומח הלענה רק את המדרונות הצפוניים והמערביים ואת יתר המורדות מאכלס צומח הזוגן.

(3) מישורי הלס הפלוביאטילי בגיאיות ובעמקים שבין ההרים והגבעות תפוסים ע"י הצומח שלהלן: בתוך אזור הצומח של לענת המדבר, מעל לגבה של 700 מ', שולטת חברת היפרוק התלת-כנפי. רבים מהמישורים האלה היו מעובדים מימים מקדם ועד מקרוב. נראה שלפנים היו מישורים אלה מכוסים חברת לענה. שבה היה היפרוק מרכיב חשוב. העבוד החקלאי השמיד בנקל את הלענה שטוחת-השרשים והשאיר את היפרוק ארץ-השרשים מחוסר יכולת לעקרו. בעמקים נמוכים מ-600-700 מ' מחליף פרקרק המדבר את היפרוק הנ"ל. הערוצים המבתרים את מישורי הלס האלה מאוכלסים על ידי צומח שבו שולטים המתנן והאכיליאה הריחנית.

ב. הצומח הסהרו-סינדי

(1) צומח החמדות. הצומח הנפוץ ביותר במדבריות החצץ של הנגב הדרומי הוא חברת יפרוק המדבר; ליפרוק נלוים כאן הפרעושית הגלגנית, האנבילאה המדברית, הסילון הקוצני, הכוכב הריחני, הכוכב הננסי וכר. חברה זאת מוגבלת לערוצים הרדודים המבתרים את מישורי החצץ העצומים ואילו המישורים עצמם ריקים מצומח.

(2) במקום שערוצים אלה רחבים ועמוקים יותר נלוים אל היפרוק ומלוויו צמי שיטה. כגון השיטה הסלילנית ושיטת הסוכך ואתם גם אילו צמחים סודגור דקניים. במקרה זה לפנינו חברת השיטה הסלילנית-היפרוקית המשוה לפעמים לגוף צורת סונה (עמק הערבה ויובליו).

(3) הצומח של חברות זוגן השיה תופס שטחים רחבים באזור הגבעות (רביבים — ניצנה — ממשית) וכן גם במורדות הדרומיים והמזרחיים של אזור ההרים.

(4) הצומח של חברות פרקרק השיה והפרקרק הפרסי. בחלקים הדרומיים של הנגב מופיע פרקרק השיה כצמח ראשי בכמה חברות. הוא נפוץ ואפיני מאד באזור אבן החול ואבני היסוד ואילו הזוגן הנפוץ מאד באזור של אבני הגיר, חסר כמעט כאן. בערוצים ובגיאיות עמוקים אשר במישורי הצומח של פרקרק השיה מופיעות קבוצות של עצי שיטים ומתות כאן את חברת השיטה הסלילנית-הפרקרקית. חוליות ושדות חול בעמק הערבה תפוסים ע"י חברת הפרקרק הפרסי ובמקום שערוצים ואפיקים מבתרים את החולות נלוה אל הפרקרק גם השבטוט המצויץ והרותם.

עתון לבוטניקה

אדר תשי"ג

סדרת ירושלים

כרך ו' חוברת א'

התפתחות הטבעת השנתית בעצי חורש ישראליים

מאת אברהם פאהן

נעשתה חקירה על קצב התפתחות הטבעת השנתית בגזע ובענפים של העצים הבאים: אלון התבור, האלון המצוי, האלה הארץ-ישראלית, האלה האטלנטית, העוזר הקוצני והחרוב. הבדיקות הראו כדלקמן:

(א) התעוררות הקאמביום של אלון התבור, האלון המצוי, העוזר הקוצני, האלה האטלנטית והאלה הארץ-ישראלית חלה בסוף מרס, ושל החרוב באמצע אפריל. (ב) הקאמביום נשאר פעיל: בעוזר הקוצני ובאלה הארץ-ישראלית מסוף מרס - התחלת אפריל עד אוגוסט - התחלת ספטמבר (כחמישה חדשים); באלה האטלנטית מסוף מרס עד סוף ספטמבר-אוקטובר (כ"6-7 חדשים); באלון התבור ובאלון המצוי הטבעת האמתית הולכת ונשלמת מסוף מרס עד מחצית או סוף אוגוסט (כ"5 חדשים). באלון המצוי התקופה ארוכה במקצת מזו של אלון התבור. באלונים האלה הקאמביום מתעורר לפעולה משנית בשלהי הקיץ והסתיו. פעילות זו נמשכת כחודש חדשים, וע"י כך נוצרות טבעות מדומות בלתי שלמות. בחרוב פעילות הקאמביום אורכת ממחצית אפריל עד מחצית פברואר או מרס (כ"10-11 חודש).

(ג) היחס שבין התעוררות של ניצני העלים ובין התעוררות הקאמביום הוא כדלהלן: בעצים נשירים (אלון התבור, העוזר הקוצני, האלה האטלנטית והאלה הא"י) ניצני העלים מתעוררים זמן נכר לפני הקאמביום, ובעצים ירוקי-עד (האלון המצוי והחרוב) ניצני העלים מתעוררים יחד עם הקאמביום.

מחקרים איקולוגיים בצומח של מדבריות המזרח הקרוב III. מפת הצומח של הנגב המרכזי והדרומי

מאת דניאל זהרי

במחקר זה ממופה בפעם הראשונה הצומח של הנגב המרכזי והדרומי. במפה המלווה את המאמר הזה הובדלו בשטח המחקר יחידות הצומח הבאות:

א. הצומח האירנו-טורני

(1) יערות ערבה של האלה האטלנטית. מהם מצויים כיום בנגב החררי (ראש חורשה, ראש רמון, הר לוצן) שרידים המוגבלים למורדות הצפוניים והמערביים של ההרים. לעצים של האלה מתלווה במקומות מסוימים האשחר הדור

עתון לבוטניקה

מופיע בשתי סדרות

א. סדרת ירושלים:

יוצאת לאור ע"י חבר העובדים של המחלקה לבוטניקה באוניברסיטה העברית, ירושלים. כל כרך מכיל 4 חוברות (250 עד 350 עמודים).

ב. סדרת רחבות:

יוצאת לאור ע"י ה. ד. אופנהימר וז. ריכרט מהתחנה לחקר החקלאות, רחבות. כל כרך מכיל 2 חוברות (200 עד 250 עמודים).

*

במכתבים הנוגעים לענייני המערכת של סדרת ירושלים יש לפנות לעורכי "עתון לבוטניקה", ת. ד. 620, ירושלים — ולענייני המערכת של סדרת רחבות לעורכי "עתון לבוטניקה", ת. ד. 15, רחבות.

*

את דמי התחילה יש לשלם למפרע ע"י שק או המחאת דואר למי הכתובת: ההנהלה של העתון לבוטניקה, ת. ד. 620, ירושלים. מחיר התחילה הוא:
4.000 ל"י לכרך, בעד סדרת ירושלים
1.000 ל"י בעד חוברת בודדת
מחיר הכרכים הקודמים של סדרת ירושלים 6.000 ל"י כ"א.
מחירים אלה אינם כוללים את דמי המשלוח.

ע ת ו ז ל ב ו ט נ י ק ה

סדרת ירושלים

יוצא לאור על ידי

חבר העובדים של המחלקה לבוטניקה באוניברסיטה העברית

ת כ ן

עמוד

- א התפתחות הסכעת השנתית בעצי חורש ישראליים. מאת אברהם פאהן
מחקרים איקולוגיים בצומח של מדבריות המזרח הקרוב. III. מפת הצומח של הנגב
א המרכזי הדרומי. מאת דניאל זהרי
ג תוססת חדשה להכרת הפטריות של ארץ ישראל (חלק ששי). מאת טשרנה רייס
ג השפעת 2,4-D וקומריק על גשימת זרעים גובטים של חיטה וחסה. מאת רות לבארי
מעבדי גביטה ומערכות אנוימטיות צמחיות. II. דהידרוגנוזות.
ד מאת אלכסנדרה פוליקוב-מיכר
ד בדוד אלו אירגנומים שהם אנטיביוטיים לגבי פטריות מיטופתוגניות. מאת מרגלית כץ